BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Service Paper

AN INTEGRATED COURSE OF STUDY IN GENERAL SCIENCE FOR THE THREE CONSECUTIVE GRADES IN THE JUNIOR HIGH SCHOOLS OF A SMALL INDUSTRIAL CITY.

SUBMITTED BY

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INTRODUCTION

Statement of the Problem

To organize an integrated course of study in general science for the three consecutive grades in the junior high schools of a small industrial city.

A Felt Need

The author discovered that there was no course of study for general science in grade nine when she began to teach said subject in X-city. This lack was a decided handicap. However, as time went on, with the aid of the prescribed textbook and many reference books, the author prepared a teacher's outline which she has used in the subsequent years making changes where they were deemed necessary.

Two years ago the administration saw fit to include general science in the curriculum for grades seven and eight. Here again, it was introduced without a course of study to guide the teachers selected to teach the subject. Since that time the subject--general science--has been introduced and intermingled with the course content of the nature classes in the elementary schools.

It now seems fitting that some kind of outline should be prepared to show the extent to which the subject is covered in the elementary schools and a course of study for the junior high school grades should be prepared so that there will not be too much repetition of subject matter in grades seven, eight, and

nine.

The preceding statement gives the scope of this service paper.

CHAPTER I

AIMS OF SECONDARY SCHOOL EDUCATION

John Dewey, generally accepted as the greatest modern educational philosopher, defines education as[1]

> "that reconstruction or reorganization of experiences which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience."

The above definition presents the aim of education in general.

The category of aims of secondary education most widely accepted is the one announced by the Commission on the Reorganization of Secondary Education.[2] The seven objectives decided upon by the Committee are health, command of fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, and ethical character. Science instruction is especially valuable in the realization of six of these objectives.[3]

1. "Health -- It is important that those who are ill may be cured, but it is much more important that people be so taught that they may not become ill. It is the duty of the school

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[1]John Dewey, Democracy and Education, pp. 89-90. New York: The Macmillan Company, 1916.

[2]Cardinal Principles of Secondary Education, pp. 5-10. United States Bureau of Education Bulletin No. 35, U.S. Dept. of the Interior, Washington: Government Printing Office, 1918.

[3]Reorganization of Science in Secondary Schools, pp. 12-15. United States Bureau of Education Bulletin No. 26, Washington: Government Printing Office, 1920.

to furnish such material for all pupils as will give them a wide knowledge and practice of the foundational principles of personal hygiene control and public sanitation, which will bring about the control and elimination of disease, the provision of adequate hospital facilities and medical inspection, and the maintenance of public health.

2. Worthy Home Membership -- Science has devised many conveniences that make the modern home comfortable and attractive, and science knowledge is required for their full appreciation and most intelligent use.

3. Vocation -- Science instruction should contribute both to vocational guidance and to a broad preparation for vocation. Often a knowledge of the underlying scientific principles increases the worker's enjoyment, helping him to think intelligently about and to understand the processes with which he deals. Moreover, such knowledge and interest aroused thereby may result in inventions for the improvement of the work of others.

4. Citizenship -- Science needs to have a much greater appreciation for the work of scientifically trained men and women. Science teaching should, therefore, be especially valuable in the field of citizenship because of the increased respect which the citizen should obtain for the expert, and should increase his ability to select experts wisely for positions requiring expert knowledge. It should also furnish a foundation for an intelligent evaluation of the services rendered by such experts.

5. Worthy Use of Leisure Time -- Science provides an opportunity for many useful and pleasurable avocations. Science instruction should stimulate, encourage, and give guidance to hobby interests of many kinds. The importance of such interests in their relation to mental health, to purposeful occupation, and to possible future inter-

ests is now widely recognized.

6. Ethical Character -- Science should assist in the development of ethical character by establishing a more adequate conception of truth and a confidence in the laws of cause and effect. Science, along with other subjects that exalt truth and establish laws, should help develop sane and sound methods of thinking upon the problems of life."

AIMS OF THE JUNIOR HIGH SCHOOL CURRICULA

Two of the fundamental purposes of the junior high school are stated by Briggs[4] as follows: "To explore by means of material in itself worthwhile interests, aptitudes and capacities of pupils and to reveal to them, by material otherwise justifiable, the possibilities in the major fields of learning."

Several authorities concur in the general aims of the junior high school. Their lists include the following objectives:

1. To maintain and improve certain health habits.
2. To maintain and develop a satisfactory command of the English language.
3. To maintain and further develop the fundamental processes.
4. To develop socially acceptable conduct habits as a member of a small group -- the family.

[4]Thomas H. Briggs, The Junior High School, p. 26. Boston: Houghton-Mifflin Co., 1920.

5. To develop proper functional habits and attitudes, political and social, for a democratic society.
6. To develop proper vocational work attitudes by securing a command of facts and habits which are of a general vocational nature.
7. To acquaint the individual with the means of occupying his leisure time to best advantage.

It is difficult to understand how many pupils in junior high school can be guided intelligently in their choice of differentiated curricula unless the field of science is revealed to them. General science in the junior high school is perhaps the most important science instruction given. It is the science instruction which reaches the greatest numbers of pupils. It is in most cases the first formal instruction in science as such; it is in many cases the last instruction in science. Consequently its functions are both introductory and terminal, both general and specialized.

ACCEPTED AIMS OF JUNIOR HIGH SCHOOL SCIENCE

"General science is the study of man's environment. It gives him an understanding of his surroundings. It shows the individual his relationship to the factors of his environment

and stresses the importance of man's control of these factors. It demonstrates the necessity for adaptability in order that he may secure for himself life enrichment."[5]

Before 1850 there were two fundamental aims of science instruction. The original aim was to stress the informational value of science instruction, and the second or religious aim was that nature was to be taught to be the handiwork of God. Today the primary aims of science teaching are:

1. To develop an understanding of nature and the organization of the environment.
2. The attainment of health through appreciating its values to society and to the individual.
3. The acquisition of desirable habits of work and study.
4. To inculcate habits of thinking that contribute to the scientific attitude.
5. The development of the ability to use the scientific method.
6. The development of interest in science for worthy use of leisure time.
7. To provide an opportunity for exploration in the various fields of science.

[5]Course of Study in Junior High School Science, p. 1. Brockton Public Schools, Brockton, Mass., 1942.

SUMMARY

The objectives of secondary education decided upon by the Commission on the Reorganization of Secondary Education in 1918 are health, command of the fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure time, and ethical character. All of the aims and objectives of teaching general science are based upon the "Seven Cardinal Principles." The objectives of general science can be condensed into the following general aims:

1. To develop an understanding of the important principles of science so that the knowledge of these principles may function effectively in daily life.
2. To develop scientific attitudes.
3. To establish the scientific method of thought and procedure.
4. To recognize the value of science with reference to leisure time.

CHAPTER II

THE LOCAL SITUATION

The general purpose of this chapter is to give a brief study of the range of topics in general science which are now being taught throughout the span of school years from grade one to grade nine in X-city. It is necessary to have a firm idea of what is being taught at the elementary school level before organizing a program of general science for the junior high school so that there will not be too much overlapping of subject-matter or repetition of topics from grade to grade.

SCIENCE IN THE ELEMENTARY SCHOOLS OF X-CITY

Not too long ago, science was considered unsuitable for primary grades because it was thought that young children could not be expected to reason. Now it is generally recognized that if the materials used are within their realm of experience, primary-grade children can do good science thinking on simple levels.

The function of science in the elementary school[1] is

> "much more than merely acquainting children with the names of rocks and securing interesting information about the individual species of plant and animal life. The new program of science, which emphasizes the development of desirable social behavior, is organized around problems that have social value and are challenging and worthwhile to children."

[1]Gerald S. Craig, Science in Childhood Education, p. 36. New York: Bureau of Publications, Teachers College, Columbia University, 1944.

There is an increasing tendency for general science, not merely nature study, to be taught at primary-grade levels. The value of science in the lives of elementary school children is found in:

A. Developing an understanding of
   1. Physical factors of the environment
   2. Organisms and their relationships to their environment
   3. Life processes of organisms
   4. The need for conservation of natural resources
   5. Community problems in health and sanitation

B. Developing the scientific method
   1. Ability to recognize and define problems
   2. Ability to suggest methods of solution
   3. Ability to collect data
      a. Ability to find and use books
      b. Ability to make accurate observations
      c. Ability to suggest and plan experiments
   4. Ability to draw inferences on the basis of data
   5. Ability to draw conclusions
   6. Ability to retain and make use of information

C. Developing scientific attitudes

1. Curiosity

2. Tolerance

3. Persistence

D. Broadening interests

1. Developing reading ability

2. Developing hobbies

a. Collecting

b. Constructing

The following program of science for the elementary schools of X-city is based on the seven books of Craig's New Pathways in Science Series. The time allotment for each grade is given in parenthesis.

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GRADE I

(15 min. a day)

I. Change of Seasons

A. Activities of plants during the four seasons

B. Activities of animals during the four seasons

II. Adaptations of Life

A. Purposes of different animal coverings

B. Habitat of animals

1. Above the ground

2. In the ground

III. <u>Conservation of Natural Resources</u>

A. Encouragement of bird life near us

B. Effects of various animals on plant life

1. Helpful effects

2. Harmful effects

IV. <u>The Earth's Atmosphere</u>

A. Air, a requisite for combustion

B. Effects of air pressure

V. <u>Health</u>

A. Effect of water on life

1. Plant life

2. Animal life

B. Man's need of sunshine

GRADE II

(3-25 min. periods a week)

I. <u>The Physical Environment of Life</u>

A. Weather changes

B. Importance of weather changes to living things

II. <u>Adaptations of Life</u>

A. Survival of plants through the winter

B. Preparation of some animals for winter

C. Preparation of man for winter

III. <u>The Universe</u>

A. The Sun

1. Importance to the earth
   a. Light
   b. Heat
2. Cause of day and night

B. The Moon
   1. Physical characteristics
   2. Phases

C. The Stars

IV. <u>The Earth</u>

A. Formation of soil

B. Formation of rocks

V. <u>Variety of Life</u>

A. How certain animals
   1. Make their homes
   2. Secure their food
   3. Care for their young

B. Protective adaptations of animals

VI. <u>Health and Safety</u>

A. Food obtained from plants

B. Selection of clothing dependent upon weather

<u>GRADE III</u>

(3-25 min. periods a week)

I. <u>The Universe</u>

A. The Sun

1. Distance from the earth

2. Composition

B. The Milky Way

II. <u>The Earth</u>

A. Movement

B. Preparation for plant and animal life

C. Prehistoric animals

III. <u>The Earth's Atmosphere</u>

A. Air and space

B. Work of air pressure

C. Evaporation of water into the air

IV. <u>Variety of Life</u>

A. Plants

1. Annuals

2. Perennials

3. Plants of the desert

B. Animals

1. Mammals

2. Birds

3. Fish

V. <u>Adaptations of Life</u>

A. Protection of animals against

1. Winter

2. Hunger

3. Their enemies

B. Care animals give their young

C. Scattering of seeds

VI. <u>Health and Safety</u>

A. Man's source of energy

B. Circulation

C. Respiration

VII. <u>Light</u>

A. Source of light

B. Color

GRADE IV

(5-20 min. periods a week)

I. <u>The Universe</u>

A. Revolution of earth about sun

B. Solar system

1. Planets

2. Relation to sun

II. <u>The Earth</u>

A. Gravity

B. Divisions of the earth

C. Changing surface of the earth

D. Rotation of earth on its axis

III. <u>The Earth's Atmosphere</u>

A. Clouds

B. Cause of winds

C. Applications of air pressure

IV. Adaptations to Life

A. Living habits of animals

1. Solitary animals

2. Social animals

B. Protective adaptations

1. Of plants

2. Of animals

V. Conditions Essential to Life

A. Importance of air to life

B. Importance of warmth to life

VI. Energy

A. Sources of natural energy

B. Inventions using natural energy to do work

VII. Conservation of Natural Resources

A. The work of beavers

B. Destruction wrought by termites

C. Value of plants to man

D. Conservation of wild life

E. Conservation of soil

F. Prevention of floods

G. Preservation of food

GRADE V

(5-30 min. periods a week)

I. The Universe

A. Sun

B. Stars

C. Meteors and comets

D. Moon

1. Changing appearance

2. Cause of tides

II. <u>The Earth</u>

A. Seasonal changes

B. Climates

III. The Earth's Atmosphere

A. Weather and air

B. Work of weather station

IV. <u>Life</u>

A. Difference between living and non-living things

B. Growth of yeasts

C. Seed-making plants

D. Growth of warm-blooded animals

V. <u>Adaptations of Life</u>

A. Plants store food

B. Migration of birds

C. Hibernation of animals

D. Adaptation of living things to various climates

VI. <u>Conservation of Natural Resources</u>

A. Energy resources

B. Importance of protecting small flowering plants

C. Difficulties of migrating animals

VII. Electricity and Magnetism

A. Magnets

B. Electromagnets

C. Explanation of electricity

VIII. Health and Safety

A. Needs of our bodies

B. Importance of eating a variety of food

C. Digestion of food

D. Work of the heart and blood

GRADE VI

(5-30 min. periods a week)

I. The Universe

A. Legends about the stars

B. Theory of formation of solar system

II. The Earth

A. Formation of oceans

B. Mountains, volcanoes, and earthquakes

C. Rocks

D. Fossils

III. Adaptations to Life

A. Prehistoric adaptations to changes in the environment

IV. Interdependence of Life

A. Struggle for existence among living things

B. Cultivation of plants by man

C. Domestication of animals by man

D. Interdependence of plants and animals

V. <u>Energy, Machines, and Inventions</u>

A. Man's first inventions

B. The simple machines

C. Use of animal power by man

D. Use of water power by man

E. Improvement of communication by man

F. Improvement of transportation by man

VI. <u>Health and Safety</u>

A. Need of body for minerals, vitamins, and proteins

B. Stamping out disease

C. Man-made substitutes for sunlight

D. The electric fuse as a safety switch

VII. <u>Conservation of Natural Resources</u>

A. Formation of coal

B. Mineral resources

C. Conservation of soil

VIII. <u>Variety of Life</u>

A. Variety in form, size, and habits of plants

B. Variety in form, size, and habits of animals

UNIT CONTENT OF TEXTBOOKS NOW IN USE IN GRADES VII-IX IN X-CITY

The remainder of this chapter will be devoted to an outlining of the units of work covered in the textbooks now in use in X-city. It is not the author's intent to suggest a change of textbooks at this point as the books for grade VII and grade VIII were put into the system just two years ago.

GRADE VII
(2-50 min. periods a week)

Textbook:

POWERS, Samuel Ralph
NEUNER, Elsie Flint
BRUNER, Herbert Bascom, Exploring Our World, new edition, Boston: Ginn and Co., 1946, vi + 522 pp.

I. Science in Our Lives
   A. The making of a scientist
   B. The tools of science
   C. The fun of science
   D. The ages before the age of science
   E. The work of science

II. The World of Water
   A. The need for water
   B. Life in water
   C. Properties and forms of water
   D. Water in your community
   E. Uses of water
      1. In industry

2. In navigation

3. In recreation

III. <u>The World of Air</u>

A. Extent of the air

B. Character of the air

C. Air pressure

D. Ventilation

IV. <u>The World of Rock</u>

A. Classification of rocks

B. Nature of soil

C. Conservation of soil

V. <u>The World of Living Creatures</u>

A. The "business" of living

B. The life of a tree

C. Life in the woods

D. Life in the fields

E. Adaptations of living things to various climates

F. Man's need of food

1. Three classes of foods

2. Vitamins

G. Man and his environment

VI. <u>The World of Action</u>

A. The force of gravity

B. The energy of motion

C. The energy of heat

D. The energy of electricity

GRADE VIII
(3-50 min. periods a week)

Textbook:

POWERS, Samuel Ralph
NEUNER, Elsie Flint
BRUNER, Herbert Bascom
BRADLEY, John Hodgdon, Our World Changes, Boston: Ginn and Co., 1940, vi + 565 pp.

I. The Changing Sky

A. The stars

B. The solar system

C. The moon

II. The Changing Air

A. The drama of the weather

B. The work of the weatherman

C. The weather of North America

D. The various kinds of climate

III. The Changing World of Life

A. Effect of changing seasons on plant life

B. Effect of changing seasons on animal life

C. Insects and the seasons

D. Adaptations of plants and animals for life in the desert

E. Adaptations of plants and animals for life in the ocean

F. Man's adaptations to heat and cold

IV. <u>The Changing Landscape</u>

A. Destructive forces

B. Extinct animals

C. Extinct plants

V. <u>Our Life in a Changing World</u>

A. Man's use of energy

1. Nature of food

2. Digestion of food

3. Release of energy of food

B. Health

1. Performance of healthy bodies

2. Enemies of good health

3. Rules for healthful living

VI. <u>Conservation in a Changing World</u>

A. Conservation of plant and animal resources

B. Conservation of minerals and soils

GRADE IX

(5-50 min. periods a week)

Textbook:

CARPENTER, Harry A.
WOOD, George C., Our Environment: How We Use and Control It, (revised edition), Boston: Allyn and Bacon, 1940, xii ≠ 810 pp.

I. Matter, Work, and Energy

A. Our environment

B. Work in our environment

1. The materials of work

2. Relation of matter to energy

3. Relation of work to matter

II. The Work of the Factors of Our Environment

A. Man's use of air

B. Air, fire, and living things

C. Water and its work

D. Community water supply

E. Sources and control of heat

F. Our use and control of light

G. Magnetism and the work of electricity

III. Importance of Industry

A. The work of water, heat, and electricity in industry

B. Travel on land, water, and in the air

C. Use of electricity in communication

IV. <u>Source of All Energy</u>

A. Preparation of earth for life

B. Sun as center of universe

C. Relation of solar energy to weather

V. <u>Storage and Use of Solar Energy by Living Things</u>

A. Relation of solar energy to work of plants

B. Use of environmental factors in agriculture

VI. <u>The Work and Care of the Human Body</u>

A. Foods as fuels for the human body

B. Use of fuels by the human body

C. The work of controlling the human body

VII. <u>Work of Protecting the Human Body from the Dangers in Its Environment</u>

A. Micro-organisms and their work

B. Preservation of health in the home

C. Protecting the community from the dangers of its environment

VIII. <u>The Work of Improving Living Things</u>

A. The origin of life

B. The conservation and improvement of life

CHAPTER III

CONTENT OF JUNIOR HIGH SCHOOL GENERAL SCIENCE COURSES

It has been generally conceded that most general science textbooks contain a superabundance of material. It is impossible to teach all the topics contained within the covers of a reputable textbook during one school year. Thus, before organizing a course of study in general science suitable for a particular community, it seemed fitting to make a brief survey of courses offered by a few widely-separated cities and towns of the country and to form a survey of the unit content of several popular textbooks of general science. The purpose of these surveys is to discover which units of work or topics are the most common for each grade in the junior high school.

SURVEY OF COURSES OF STUDY

A cross-section of the country is represented in the courses of study[1] included in the following survey:

GRADE VII

	City or State							
Topics	A	B	C	D	E	F	G	Frequency
The Work of the Scientist	x		x	x		x		4
Water	x	x		x	x		x	5
Air	x	x		x	x			4
Fire				x	x	x	x	4
Rocks and Soil	x	x			x		x	4
Matter						x	x	2
Magnetism						x	x	2
Plants and Animals						x		1
Forms-Forces of Energy			x					1
Science of the Heavens		x	x				x	3
Flowers and Plants					x		x	2
Weather and Climate		x						1
Health					x			1
Balance in Nature						x		1

Of the fourteen topics listed in the survey for grade VII, the least number developed in any one city was four and the greatest number was seven. According to the frequency distribution table, the six most common topics are:

Water
The Work of the Scientist
Air
Fire
Rocks and Soil
Science of the Heavens

[1]These courses of study are listed in the bibliography at the end of this chapter.

GRADE VIII

Topics	City or State A	B	C	D	E	F	G	H	Frequency
Weather and Climate	x		x	x	x	x	x	x	7
Food				x	x			x	3
Improving Living Things	x	x							2
Water					x	x			2
The Heavens	x				x	x	x		4
Use and Control of Heat				x			x		2
Household Wastes						x			1
Sound								x	1
Gardening					x	x		x	3
Magnetism		x							1
Energy		x					x	x	3
The Earth's Surface							x		1
Health and Hygiene		x	x				x		3
Minerals and Fossils			x						1
Safety			x		x				2
Modern Communication								x	1
Modern Transportation								x	1

Of the seventeen topics listed in the survey for grade VIII, the least number developed in any one city was three and the greatest number was seven. According to the frequency distribution table, the six most common topics are:

Weather and Climate
The Heavens
Conservation of Food
Gardening
Forms and Uses of Energy
Health and Hygiene

GRADE IX

Topics	A	B	C	D	E	F	G	H	I	"f"
	City or State									
Matter, Work, and Energy ✓					x	x	x			3 9
Adaptation to Environment ✓			x		x			x	x	4 3
Uses of Light Energy ✓			x	x	x	x	x	x	x	7 1
Living Things (characteristics)				x					x	2
Simple Machines ✓			x		x			x		3 8
Improving Living Things ✓	x				x			x	x	4 4
Clothing and Shelter					x					1
Electricity			x	x	x			x		4
Changing Surface of Earth ✓	x	x	x							3 10
Transportation						x				1
Uses of Forces of Nature ✓	x	x		x				x		4 5
Raw Materials of Earth ✓	x		x	x						3 11
Air and Its Work				x	x	x	x			4
Rocks and Soils					x					1
Water and Its Work ✓				x	x	x	x			4 6
Heat ✓				x	x	x	x		x	5 2
Work of Solar Energy						x	x			2
Solar System ✓		x		x					x	3 12
Use of Food by Body ✓					x	x	x			3 13
Micro-organisms						x				1
Food Conservation				x			x			2
Conservation of Nat. Resources									x	1
Hygiene and Sanitation					x			x		2
Sound ✓			x		x	x		x		4 7

Of the twenty-four topics listed in the survey for grade IX, the least number developed in any one city was three and the greatest number was thirteen. According to the frequency distribution table, the nine most common topics are:

Use of Light Energy
Heat
Adaptation to Environment
Improving Living Things

Magnetism and Electricity
The Uses of the Forces of Nature
Air and Its Work
Water and Its Work
Sound

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SURVEY OF TEXTBOOKS

As there are any number of well-organized textbooks in the field of general science at the junior high school level, the survey of the unit content of such books will be limited to those written in series to cover the range from grade VII to grade IX. Six of the most popular of such series[2] were selected to be used in the survey.

[2]All textbooks used in the survey are listed in the bibliography at the end of this chapter.

GRADE VII

Topics	A	B	C	D	E	F	Frequency
	Textbook						
Water	x		x	x	x	x	5
Rocks and Soil	x	x	x	x	x	x	6
Air	x		x	x	x	x	5
Fire	x	x			x		3
The Human Body	x		x		x	x	4
Food		x				x	2
Plants and Animals		x	x				2
Magnets and Electricity		x				x	2
Composition of Things		x	x	x			3
Adaptation to Environment				x	x	x	3
The Earth in Space						x	1
Heat						x	1
Light						x	1

Of the thirteen topics listed, just one--Rocks and Soils--was developed in all of the six textbooks. The four topics having the highest frequencies are:

Rocks and Soils
Water
Air
The Human Body

GRADE VIII

Topics	Textbook A	B	C	D	E	F	Frequency
The Heavens	x	x	x	x	x	x	6
Weather and Climate	x	x	x	x	x		5
Water	x	x	x	x		x	5
Community Sanitation	x						1
Farm and Garden	x			x			2
Conservation of Health	x	x	x	x	x	x	6
Uses of Energy		x	x	x			3
Control of Heat		x	x	x		x	4
Surface of the Earth		x	x	x	x	x	5
Interdependence of Life		x	x	x	x	x	5
Protection against Disease		x				x	2
Light and Electricity			x	x		x	3
Conservation of Minerals					x		1
Adaptation to Environment					x	x	2
Air						x	1
Electricity			x	x		x	3
Simple Machines						x	1
Bacteria						x	1

Of the eighteen topics listed, two--<u>The Heavens</u> and <u>Conservation of Health</u>--were developed in all of the six textbooks. Four other topics were included in five of the six books. They are:

Weather and Climate
Water
The Changing Surface of the Earth
Interdependence of Life on the Earth

GRADE IX

Topics	A	B	C	D	E	F	Frequency
	Textbook						
Matter, Work, and Energy	x	x	x	x	x		5
Air	x		x	x	x	x	5
Fire	x	x	x	x		x	5
Water	x	x		x	x	x	5
Heat	x	x	x	x	x	x	6
Light	x	x	x	x	x	x	6
Magnetism and Electricity	x	x	x	x	x	x	6
Importance of Industry	x	x	x			x	4
Transportation	x	x			x	x	4
Communication	x	x		x	x		4
Life on the Earth	x	x	x	x	x	x	6
Solar System	x	x		x	x	x	5
Weather	x	x		x	x	x	5
Work and Care of Body--Foods	x	x	x		x		4
Nervous System	x		x		x		3
Micro-organisms	x	x		x	x		4
Preservation of Health	x	x	x	x	x	x	6
Surface of the Earth		x	x	x	x		4
Conservation of Nat. Resources		x	x	x	x	x	5
Balance in Nature				x			1

At the ninth grade level, five of the twenty topics listed in the survey were found in all the textbooks. They are:

Heat
Light
Magnetism and Electricity
Preservation of Health
Life on the Earth

There seems to be more of an agreement in the selection of topics at this grade level than at the other two. Just two of the twenty topics were developed in fewer than four of the textbooks used for the survey.

The highest-ranking (6-8) topics in the separate surveys are now listed together for a quick comparison. Underneath this parallel representation for each grade are those high-ranking topics that were listed in both the courses of study and the textbooks with their total frequencies.[3]

GRADE VII

Courses of Study	f	Textbooks	f
Water	5	Rocks and Soil	6
Work of the Scientist	4	Water	5
Air	4	Air	5
Fire	4	Health	4
Rocks and Soil	4	Fire	3
Science of the Heavens	3	Adaptation to Environment	3

Topic	tf
Water	10
Rocks and Soil	10
Air	9
Fire	7

****

GRADE VIII

Courses of Study	f	Textbooks	f
Weather and Climate	7	The Heavens	6
The Heavens	4	Conservation of Food	6
Conservation of Food	3	Weather and Climate	5
Gardening	3	Water	5
Forms of Energy	3	Surface of the Earth	5
Health and Hygiene	3	Interdependence of Life	5

[3]tf = the sum of frequencies under the course of study survey and the textbook survey.

Topic	tf
Weather and Climate	12
The Heavens	10
Conservation of Food	9

****

GRADE IX

Courses of Study	f	Textbooks	f
Light	7	Heat	6
Heat	5	Light	6
Adaptation to Environment	4	Magnetism and Electricity	6
Improving Living Things	4	Preservation of Health	6
Magnetism and Electricity	4	Life on the Earth	6
Uses of Forces of Nature	4	Matter, Work, and Energy	5
Air and Its Work	4	Air	5
Water and Its Work	4	Water	5
Sound	4	Solar System	5

Topic	tf
Light	13
Heat	11
Magnetism and Electricity	10
Air	9
Water	9

****

SUMMARY

In conclusion, as a result of the survey, we find that the following topics or units of work appear to be most common for each grade in the junior high school:

GRADE VII	GRADE VIII	GRADE IX
Water	Weather and Climate	Light
Rocks and Soil	The Heavens	Heat
Air	Conservation of Food	Magnetism and Elec.
Fire		Air
		Water

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2. CARPENTER, Harry A. and WOOD, George C., Our Environment Series, Boston: Allyn and Bacon,
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(revised ed.) 1937.
Our Environment: How We Use and Control It,
(revised ed.) 1940.

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Science in Our World of Progress, 1935

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The World Around Us
This Changing World
Man's Control of His Environment

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CHAPTER IV

PROPOSED COURSE OF STUDY IN GENERAL SCIENCE FOR THE JUNIOR HIGH SCHOOLS OF X-CITY

Objectives of Course

The mere acquisition of facts of science must never be considered the major outcome of science education; rather should the child acquire those ideals and attitudes of understanding and appreciation which, based upon a knowledge of the fundamental facts and principles of science and upon the method of science, will help make him a more useful citizen.

The general objectives of this course of study in general science for the junior high school are six in number:

1. To help the pupil understand his environment.
2. To develop keener thinking ability.
3. To develop in students the ability to use the scientific method: to seek accurate information from reliable sources and to form conclusions based on this information.
4. To develop an understanding of some of the major concepts of science as they relate to the factors of the environment.
5. To develop an appreciation of natural phenomena and an understanding of the contributions of science to modern life and the progress of scientific knowledge.

6. To encourage pupils in the use of scientific information in their daily lives.

****

The scope of subject-matter for each grade in the junior high school in this proposed course of study is as follows:

<u>Grade VII</u>

An introductory survey and analysis of the most important features of everyday environment.

<u>Grade VIII</u>

A study of environment as it relates to the existence and welfare of man.

<u>Grade IX</u>

A study of man's increasing control of environment through the agency of scientific knowledge.

The courses of study proposed in this paper are based on the textbooks now in use in the school system of X-city. However, as there is more material in any textbook of general science at the junior high school level than can be thoroughly taught during the time allotted to the course, just the most important units and topics and those topics especially valuable because of local conditions will be included in the courses. The topics listed in the concluding paragraph of chapter III of this paper will serve as the primary units of the course for each grade.

It is imperative that all teachers of each grade should cover about the same amount of work and thus give the pupils the proper background for the science courses for the subsequent year or years. The units outlined in this paper should be considered as the minimum requirements for each grade. The time allotment for each unit is flexible--it may vary with the individual teachers because of the diverse factors which may retard the completion of the work. Some of the topics in the textbooks not included in these courses of study may be developed if the time permits it.

These proposed courses of study will introduce each unit with a list of basic principles. The principles express fundamental truths in science that are general in their significance and in their development. It is hoped that the pupils will acquire an understanding and interpretation of environmental phenomena which will enable them to meet new situations intelligently.

Considerable investigated evidence shows that not only can principles be effectively taught, even to elementary school children, but also that an understanding of principles persists long after mere factual information has been forgotten.

The Committee who worked on the Thirty-First Yearbook recognized that "the objectives of science teaching are the functional understanding of the major generalizations of science and the development of associated scientific attitudes."[1]

[1]A Program for Teaching Science, p. 57. National Society for the Study of Education, Thirty-First Yearbook, Part I. Bloomington, Illinois: Public School Publishing Co., 1932.

In the Review of Educational Research, October, 1942, Francis D. Curtis states, "There is an increasingly strong emphasis upon the teaching of principles of science . . . at all levels through the elementary and junior high school."[2]

Although generalizations and fundamental concepts are teachers' goals, they are not so evident to the pupils. Therefore science courses must lead the child to see and later to understand the reasons for many simple demonstrations to the end that these understandings will lead to the goal of forming correct generalizations. These generalizations should be so mastered that they may be used by the student in explaining new science experiences with which he is continually coming in contact. Science teaching will never function with the mere learning of generalizations; they must be used and applied intelligently in other science situations.

The course of study for each grade will be followed by an illustrative unit which will guide the teacher in organizing the other units of the course. The following will be the sample units for each grade:

Grade VII ---- Unit III ---- The World of Air

Grade VIII --- Unit II ----- The Changing Air

Grade IX ----- Unit VIII --- Magnetism and Electricity

[2]Francis D. Curtis, "Teaching of Science in Grades VII, VIII, and IX." Review of Educational Research, XII, p. 384, October, 1942.

Résumé of Development of Sample Units

Unit objectives and outlines of content, organized to follow the same sequence of topics as the textbook, have been included to give the teacher a brief study of the purposes and range of the unit. The units are organized in terms of problems. Each problem has its own set of aims, a suggested teacher approach, methods of collecting data, and conclusions which should assist in solving the problem.

The vocabulary words listed at the beginning of each problem suggest those terms with which the pupils should become familiar in order to thoroughly understand the subject-matter of the unit. The survey questions focus the pupil's attention on the work of the unit and recognize that he is already in a position to contribute something to the subject. The questions are not suggested as "test questions," but rather as "conversation openers" to help develop and motivate investigation of the problem.

The thought questions found at the end of the development of the unit along with a possible repetition of the "survey" questions listed in the introduction to each problem will serve as a form of review of what has been assimilated by the pupils. Evidence of mastery will be discovered by giving objective tests, samples of which will be found at the end of each problem. The final test is important; it will show how successful the teacher has been in the development and treat-

ment of the unit. A "unit" test designated to cover the entire range of topics in the unit should be formulated by each individual teacher for he is the one best qualified to know where the stress has been placed.

The bibliography includes both teacher and pupil references. A complete list of all books referred to in the development of the unit plus several excellent reference books will be found in the bibliography. Just those books that are easily accessible--those that are already on the reference shelves of X-city have been listed. Each teacher may wish to add books of his own choosing to the list.

CHAPTER V

PROPOSED COURSE OF STUDY IN GENERAL SCIENCE FOR GRADE VII

Scope

According to the survey described in Chapter III, the four most common topics taught in grade VII are:

Water
Rocks and Soil
Air
Fire

The above topics form the basis for the greater part of the course to be proposed in this chapter. The topics air and fire will be combined under one unit. The introductory unit Science in Our Lives is necessary for general background material. A concensus of opinion among the teachers now teaching general science in grade VII lead to the selection of the additional unit--Unit V, The World of Living Creatures.

The time allotment for each unit is arbitrary--however, provision should be made to complete adequately the five units outlined in this chapter.

Objectives

1. To help the pupil to understand his environment.

2. To give an appreciation and enjoyment of the wonders of nature.

3. To help pupils understand that things happen in nature in accordance with law.

4. To develop an understanding of some of the major concepts of science as they relate to the factors of the environment.

5. To develop the scientific attitudes of open-mindedness, suspended judgment, intellectual honesty, and looking for true cause and effect relationships.

6. To build up a scientific vocabulary.

7. To encourage pupils to find recreational and cultural interests in science.

Outline of Minimum Course Requirements

Unit One -- Science in Our Lives
(two weeks)

I. What is science?

A. The making of a scientist

B. The tools of science
1. Observation
2. Measurement
3. Experimentation
4. Good thinking

II. What has science done for us?

A. The age of science

B. The ages before the age of science

C. The effect of science on the world

D. The scientific method

****

Unit Two -- The World of Water
(eight weeks)

Principles

1. All matter is either a solid, a liquid, or a gas.

2. The pressure of water increases with its depth.

3. Water exerts pressure because of its weight.

4. Evaporation requires heat.

I. Is water necessary to life?

A. The need for water

B. Creatures that live in water
1. Visible
2. Microscopic

C. How water creatures live
1. Why water animals die on land
2. How a fish breathes
3. Plants of the water world

II. What is water?

A. Properties of water
1. Physical
2. Chemical

B. Forms of water
1. Solid
2. Liquid
3. Gaseous

C. Thermometer
1. Uses
2. Kinds of scales
a. Fahrenheit
b. Centigrade
3. Fixed points on both scales

D. Water cycle
1. Source of water
2. Process of evaporation

III. How do we get the water we need?

A. Water in your community
1. Impurities in the water
a. Dissolved
b. Living
2. Maintaining an adequate supply of good water
a. Steps in purifying community water
b. Distribution

B. Safe water in the country
1. Locating wells
2. Protecting wells and springs

IV. How do we use water in our work?

A. Water for power
   1. Work and power
   2. From water wheel to turbine
      a. Importance of abundant rainfall
      b. Importance of falls, lakes, and reservoirs
   3. The future of water power

B. Water for irrigation
   1. Meaning of irrigation
   2. The magic of irrigation
   3. The value of irrigation

C. Water for navigation
   1. Ocean navigation
   2. Fresh-water navigation

D. The water harvest
   1. Food
   2. Fur
   3. Fun
   4. Health

E. The conservation of water
   1. The problem of conservation
   2. The water in the ground
      a. Ground or underground water
      b. The water table
   3. Danger of run-off water
      a. Erosion
      b. Floods

****

<u>Unit Three -- The World of Air</u>
(eight weeks)

<u>Principles</u>

1. Every body has weight and occupies space.

2. Every substance is either an element, a compound, or a mixture.

3. Air exerts pressure because of its weight.

4. The air exerts pressure on every surface it touches.

5. The pressure of the air decreases as the altitude increases, and increases as the altitude decreases.

6. When anything burns, oxygen is used and carbon dioxide is given off.

7. Oxygen is necessary for burning.

I. How does air behave?

   A. Where we find air
      1. The air around us
      2. The air above us

   B. Air is a very real thing
      1. Air occupies space
      2. Air has weight

   C. The pressure of air
      1. The measurement of air pressure
         a. Instrument used
         b. Kinds of barometers
      2. Warm air and cold air
      3. The wind

   D. Exploring the ocean of air
      1. The fire balloon
      2. Modern balloons

II. What is air?

   A. Air is a mixture of gases
      1. Oxygen
         a. Occurrence in the air
         b. Importance
      2. Carbon dioxide
         a. Produced by burning
         b. Study of elements and compounds
      3. Nitrogen
         a. Occurrence
         b. Purpose
      4. The rare gases
         a. Argon
         b. Helium
         c. Neon
         d. Krypton

B. The water in the air
   1. Sources
   2. Importance

III. What are the differences between good and bad air?

A. The dust in the air
   1. Non-living dust
   2. Living dust
      a. Pollen
      b. Molds
      c. Yeasts
      d. Bacteria

B. The need for cleanliness
   1. Clean and unclean habits
   2. Why cleanliness pays

C. Dangerous gases in the air
   1. Production of carbon monoxide
   2. Its effects

D. The conservation of air
   1. What makes air good
      a. Proper amount of oxygen and carbon dioxide
      b. Proper temperature
      c. Proper humidity
      d. Proper air movements
   2. Ventilation
      a. Natural
      b. Artificial

****

<u>Unit Four -- The World of Rock</u>
(six weeks)

<u>Principles</u>

1. Rock fragments and organic remains form soil in which plants grow.

2. Rocks are made in three ways: under water, by pressure, and by heat.

I. What is rock?

A. How to classify rocks
1. Texture
2. Grain

B. Classes of rocks
1. Igneous
a. Coarse-grained
b. Fine-grained
c. Glassy
2. Sedimentary rocks
a. Coarse-grained
b. Irregularly-grained
c. Fine-grained
3. Metamorphic rocks

II. What is soil?

A. How soil is made
1. Weathering of rocks
a. Acid
b. Heat and cold
c. Freezing water
d. Growing things
2. Glaciers

B. The nature of soil
1. Broken rock
2. Humus
3. Water
4. Air
5. Soluble mineral matter

C. The different kinds of soil
1. Gravelly
2. Sandy
3. Clayey
4. Loamy

D. Why good soil is good

E. The conservation of soil
1. The menace of floods
a. The wrong kind of flood control
b. The right kind of flood control
2. How our soils may be saved
a. Forest conservation
b. Grassland conservation
c. Plowed-field conservation

Unit Five -- The World of Living Creatures
(twelve weeks)

Principles

1. All living things must adapt themselves to the conditions under which they live or become extinct.

2. All life comes from pre-existing life and reproduces its own kind.

3. All living things require food.

4. Man's way of living is governed by the conditions that surround him on the earth.

5. There is a very great variety and range in the size, structure, and habits of organisms.

6. Efficient living is dependent upon knowledge of the principles of health and sanitation.

****

I. What is the business of living?

- A. All living things must
  - 1. Eat
  - 2. Protect themselves
  - 3. Reproduce
- B. The life of a tree
  - 1. Parts of a tree
    - a. Roots
    - b. Trunk
    - c. Branches
    - d. Leaves
  - 2. Self-protection of a tree
  - 3. How a tree reproduces
- C. The lives of other creatures
  - 1. The kingdom of plants
  - 2. The kingdom of animals
  - 3. Insects

II. What is the web of life?

A. The web of life in the woods
1. The nursery in the woods
2. The nursery beneath the dead leaves

B. The web of life in the fields
1. A world of grass
2. The partnership of bacteria and clover
3. The partnership of clover and the bee

C. How living things co-operate
1. How unlike creatures co-operate
2. Gregarious living
3. Social living
4. The balance of life
5. The conservation of wild life
a. Forests
b. Wild grasses and flowers
c. Birds
d. Fish and game

III. How are creatures fitted for the lives they lead?

A. Adaptations to the water
1. Life near the bottom of the sea
2. Life along the shore of the sea
3. Life in fresh water

B. Adaptations to the land
1. Walkers and runners
2. Burrowers
3. Climbers
4. Fliers

C. Adaptations to different climates
1. Polar regions
2. Tropical regions
3. Desert regions
4. Temperate regions

IV. What part does food play in our lives?

A. The richness and variety of our diet

B. How science helps us with our eating

C. The three great classes of foods
1. Carbohydrates

2. Fats
3. Proteins

D. Our need for mineral matter
1. Salt
2. Water
3. Calcium and phosphorous
4. Iron and iodine

E. Our need for vitamins
1. Vitamin A
2. Vitamin B
3. Vitamin C
4. Vitamin D
5. Vitamin G

F. The balanced diet

V. How does man fit into the web of life?

A. Man and his environment
1. Man's dependence on his environment
2. The adaptations of man

B. Man, a creature of communities
1. Effects of community living
2. Transportation in a modern world
3. Communication in a modern world
4. Housing in a modern world
5. Public health in a modern world

C. Man, a creature of responsibility

Sample Unit

Unit Three -- The World of Air

Major Generalization

The earth and its life are greatly affected by the ocean of air which completely surrounds it.

Unit Objectives

1. To learn why man is dependent upon air.

2. To learn how man can control and use air for more efficient living through a knowledge of its properties and composition.

Outline of Content

I. How does air behave?
   A. Where we find air.
   B. Air occupies space and has weight.
   C. The pressure of air.
      1. Meaurement.
      2. Cause of winds.
   D. Exploring the air.
      1. The development of balloons.
      2. Famous balloon flights.

II. What is air?
   A. Air is a mixture of gases.
      1. Oxygen.
      2. Nitrogen.
      3. Carbon dioxide.
      4. Water vapor.
      5. Several rare gases.
   B. Elements and compounds.

III. What are the differences between good and bad air?
   A. The dust in the air.
      1. Non-living dust.
      2. Living dust.
   B. The need for cleanliness.
   C. Dangerous gases in the air.
   D. The conservation of air.
      1. What makes air good?
         a. Proper amount of oxygen and carbon dioxide.

b. Proper temperature.
c. Proper humidity.
d. Proper air movement.
2. Ventilation in the home.

****

Standards of Achievement[1]

A knowledge of the physical characteristics of air; its composition; occurrence; active element; relation to life; mechanical uses.

How to demonstrate air pressure, weight of air, space occupied; the presence of water vapor in the air.

The correct method of ventilating a room.

****

Problem I -- How does air behave?

Aims: 1. To discover if air occupies space and has weight.
2. To find out if the weight of air is of any importance to man.

Vocabulary

altitude	gas	partial
atmosphere	helium	pressure
balloon	hydrogen	quantity
barometer	meteor	vacuum
exert	occupy	volume
	oxygen	

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. How do you know that air is all around you?

2. What would happen if the earth's air supply were gone?

3. How does air on a tall mountain differ from air at sea level?

[1]These should be considered as the minimum accomplishments of the unit. However they are subject to changes and additions due to local conditions.

Topic 1 -- Where we find air. (pp. 161-164)

Demonstrations

1. Is there air in soil?
   text, p. 162
   (Use water that has been boiled for this demonstration. Why?)

2. Is there air in water?
   Fill a pan with as cold water as you can secure. Let the pan remain in a warm room for twenty minutes or so. What do you observe?

3. Is there air in wood?
   text, p. 162

Topic 2 -- Air is a very real thing. (pp. 164-167)

Demonstrations

1. Does air occupy space?
   text, p. 162

2. Does air have weight?
   text, p. 166 or
   Wood and Carpenter, p. 95

Topic 3 -- The pressure of air. (pp. 167-174)

Demonstrations

1. How can you show that air has pressure?
   text, p. 170 or
   Wood and Carpenter, p. 97, part B of key experiment 3

2. How is the pressure of air measured? (optional)
   Wood and Carpenter, p. 102

3. Which is lighter: warm air or cold air?
   text, p. 172

Things to Do
(These suggestions may be worked out as group work in class or as individual reference work by the teacher or pupils.)

1. Describe the water barometer of Otto von Guericke.

2. Describe the experiments on air pressure conducted by Torricelli and Galileo.

3. Make a list of all the ways you can think of by which men make air pressure work for them.

<u>Topic 4</u> -- Exploring the ocean of air. (pp. 174-180)

Demonstrations

1. Why will a balloon rise in the air?
text, p. 176

Things to Do

1. Read section "How does a balloon float in the air?" in <u>The World Around Us</u>, pp. 179-188 and report findings to class.

2. Compare a modern balloon with a "fire" balloon.

3. Have "The Thrilling Flight of Captain Gray" pp. 177-180 of text read in class. <u>The World Around Us</u> has a more complete description of this flight on pp. 188-190.

4. Report on Auguste Piccard's flight of August 18, 1932.

5. Prepare a booklet or poster to show the development of balloons from the earliest days to the present time. Get pictures for illustrations or else make drawings from illustrations in books and magazines.

6. Make a list of the most important events in the history of the stratosphere flights made by balloon and by airplane. (Consult World Almanacs.)

Interesting Reading for Special Assignments and Reports

The Book of Popular Science:

The Power of the Air, IV, 1226-1242
The Air in Which We Live, V, 1677-1686
Otto von Guericke, Inventor of Air Pump, XI, 3671-3672
Torricelli, Inventor of Barometer, XV, 5284-5285

The World Book Encyclopedia:

Vacuum, XII, 7439-7440
Barometer, I, 625-626

Compton's Pictured Encyclopedia:

The Invisible Ocean in Which We Live, A, 61-64
Height of Atmosphere, A, 51-52
Barometer, B, 48-49
Vacuum and Vacuum Appliances, V, 268

The New Wonder World:

The Ocean of Air, I, 76-79
The Weight of Air, I, 79-80
Stratosphere Flights, IV, 390-391
Use of Air in Industry, II, 59-60

CONCLUSIONS

Air is a necessary factor of the environment. It surrounds the earth, but decreases in density as the altitude increases. It is a real substance, occupies space, has weight, and exerts pressure on every surface it touches. Air pressure enables birds and other flying creatures to remain up in the air, and it makes possible the flying of kites and airplanes. A balloon rises when it is lighter than the air it displaces.

THOUGHT QUESTIONS

1. State two reasons for believing that air is matter.

2. How would you prove that air has weight?

3. To pour condensed milk from a can, two holes are usually punched in the top, at opposite sides. Why is the second hole necessary?

4. Why does some mercury run out of a thirty-six inch barometer tube when filled and inverted but does not run out if the tube is twenty-six inches long?

5. A gas-filled balloon will burst at very high altitudes. Explain.

6. If an aviator takes a barometer up in the air with him, what happens to the length of the mercury column as he flies higher and higher? What will happen to the length of the mercury column as he comes down?

7. Why does a toy balloon burst as you squeeze it?

8. Explain why air pressure is greater in a mine than at sea level, and greater at sea level than on a mountaintop?

OBJECTIVE TESTS

I

Multiple Choice

1. The instrument used to measure changes in air pressure is (a) the thermometer; (b) the balloon; (c) the barometer.

2. Warm air is (a) heavier than cold air; (b) lighter than cold air; (c) as heavy as cold air.

3. Helium is a better gas for balloons than hydrogen because (a) it is much lighter; (b) it cannot burn; (c) it is cheaper.

4. If the air could be taken out of a bottle so that nothing at all was left there, the space would be a (a) vacuum; (b) draft; (c) gas.

5. Air exerts pressure (a) just downward; (b) in all directions; (c) just upward.

II

True-False

1. No air is found in soil and water.

2. Air has weight.

3. An "empty" bottle is full of air.

4. At sea level, the pressure of the air is greater than it is at the summit of a mountain.

5. Helium burns very easily.

III

You will find in List A a "subject" which will make each "predicate" in List B a complete and true sentence.

List A

Galileo	Torricelli	The aneroid	34 ft.
Von Guericke	The barometer	Air pressure	30 in.

List B

1. is a type of barometer used in airplanes.

2. invented the mercury barometer.

3. holds mercury up in a tube.

4. made a water barometer.

5. is the height of a column of mercury which can be supported by the pressure of the air at sea level.

6. is an instrument used to measure air pressure.

7. is greater in a deep mine than at sea level.

8. falls when the air is full of moisture.

Problem II -- What is air?

<u>Aims</u>:
1. To find out if air is just one substance.
2. To discover the relation between air and fire.
3. To discover what part of the air makes things burn.
4. To discover the results of burning.

<u>Vocabulary</u> (Supplement to list for Problem I.)

argon	humidity	phosphorous
carbon dioxide	mixture	process
compounds	neon	temperature
elements	nitrogen	vapor
evaporation	paraffin	

SUGGESTED TEACHER PROCEDURE

<u>Survey Questions</u>

1. Why do we need to know the properties of and how to control air?

2. Discuss the possible reasons why a lighted candle goes out when you blow on it with your breath.

3. What commercial uses do we have for some of the gases found in the air?

<u>Topic 1</u> -- Air is a mixture of gases. (pp. 183-188, 197-198)

General Background Material (for teacher)

Read Meister, <u>Living in a World of Science, Book I</u> for properties and uses of some of the gases found in the air:

oxygen	pp. 90-92
nitrogen	pp. 93-94
carbon dioxide	pp. 94-97
water vapor	pp. 97-98

Use Compton's Pictured Encyclopedia or/and the Book of Popular Science for additional information about the rare gases found in the air.

Demonstrations

1. What per cent of the air is oxygen?
   Davis and Sharpe, p. 50

2. How may oxygen be prepared?
   text, p. 187

3. How may carbon dioxide be prepared?
   Davis and Sharpe, p. 58
   (Limewater is made by dissolving calcium oxide in water. It is not very soluble so place a handful of the quicklime in a gallon bottle and fill it with water. Shake and allow to settle until clear. Siphon off what is needed. When the bottle is almost empty, simply refill with water, shake and allow to settle until clear.)

4. What are some characteristics of nitrogen?
   Caldwell and Curtis, p. 36

Things to Do

1. Make a graph showing the proportions of the various gases of which the air is composed.

2. The rare gases--argon, neon, krypton, xenon, and helium--all derive their names from the Greek. Look up their derivation.

3. The story of the discovery, preparation, and use of helium is very interesting. Prepare a report on this gas and illustrate with pictures or sketches.

4. The following scientists have made important contributions to our knowledge of air: Lavoisier, Priestley, Ramsay, Cavendish, and Rutherford. Read about their work and report your findings in class.

Topic 2 -- The candle and the flame. (pp. 189-193)

Demonstrations

1. How does a candle burn?
   text, p. 189

2. Carbon dioxide is produced by burning.
   text, p. 190

3. Water is produced by burning.
   text, p. 190

Things to Do

1. Read Faraday's "Chemical History of a Candle."

2. Make a list of the more common elements and compounds. Tell what elements are found in each compound.

Topic 3 -- The water in the air. (pp. 193-196)

Demonstrations

1. Does an evaporating liquid absorb heat?
   Put a few drops of gasoline on the back of your hand and let it evaporate. Repeat using a few drops of carbon tetrachloride, ether, or alcohol. Do the liquids on your hand dry up (evaporate)? Did this make your skin feel cool?

2. What is meant by humidity of the air?
   Our World Changes, p. 128

Things to Do

1. Find the relative humidity of the classroom.

2. Make a chart showing the importance of the water vapor that is found in the air.

Interesting Reading for Special Assignments and Reports

<u>The Book of Popular Science</u>:

The Contents of the Air, VI, 1791-1799

<u>The World Book Encyclopedia</u>:

Oxygen, IX, 5281-5282
Combustion, III, 1580
Nitrogen, VIII, 5034-5035
Carbon Dioxide, II, 1193

<u>The New Wonder World</u>:

How Air Gives Up Water, I, 83
Composition of Air, X, 47; 260

CONCLUSIONS

Air is composed of a number of gases, including among others nitrogen, oxygen, neon, and carbon dioxide. The first two combined make up ninety-nine per cent of the air. There is also water vapor in the air. Humidity refers to the amount of water vapor in the air.

THOUGHT QUESTIONS

1. Explain why burning does not consume all the oxygen in the air.

2. Why does a splint of wood burn more brightly in oxygen than in air?

3. Name the substances which compose the air, in order, beginning with the most abundant.

4. What would be likely to happen if the air were suddenly to change its proportions of oxygen and nitrogen so as to be made up of about four parts of oxygen to one part of nitrogen?

5. If a dry, clean glass is held inverted over a lighted

candle for a few moments, moisture will form on the inside of the glass. Where does this moisture come from?

6. William discovered a fire in a closet. He left the door open and ran for water. What mistake did he make? Why?

7. If you had a tank of oxygen and a tank of carbon dioxide which should you use to put out a fire? Why?

8. One of the gases in the air is termed the "lazy gas." Which gas is it? Why is it called the "lazy gas?" What is its value in the air?

OBJECTIVE TESTS

I

Multiple Choice

1. The gas necessary for burning is (a) nitrogen; (b) oxygen; (c) carbon dioxide.

2. About 78% of the air is (a) nitrogen; (b) oxygen; (c) carbon dioxide.

3. Smoke is unburned (a) hydrogen; (b) carbon; (c) oxygen.

4. Humidity refers to (a) the temperature of the air; (b) the wind; (c) the amount of water vapor in the air.

5. Air is a mixture of (a) solids; (b) liquids; (c) gases.

II

True-False

1. Just a few elements are to be found in this world.

2. "Humidity" is another name for temperature.

3. Evaporation is a cooling process.

4. Carbon dioxide is produced in the burning of a candle.

5. If there were less oxygen in the air, things would burn less easily than they do.

III

Completion

1. Air is a .... of gases.

2. The gas necessary for life is ....

3. Paraffin is composed of two things: .... and hydrogen.

4. We call .... the "lazy" gas.

5. One of the rare gases found in the air, ..., is used in commercial signs.

IV

"Air is a mixture of several gases. It contains oxygen, nitrogen, carbon dioxide, and water vapor." Tell which of these gases is referred to in each case listed below:

1. The "life supporting element."
2. About one-fifth of the air by volume.
3. Nearly four-fifths of the air.
4. Supports combustion.
5. Relieves suffocating patients.
6. Makes humidity.
7. Carried in submarines and airplanes.
8. Product of combustion.
9. Fatal when inhaled in great quantities.
10. Is evaporated from plants and men's bodies.
11. Does not combine readily with many substances.
12. .03 per cent of the air.

Problem III -- What are the differences between good and bad air?

__Aims__: 1. To find out why ventilation is important.
2. To discover how to avoid harmful bacteria.

__Vocabulary__ (Supplement to lists for preceding problems.)

ailment	pollen
bacteria	precaution
carbon monoxide	saliva
microscope	ventilation
molds	yeast

SUGGESTED TEACHER PROCEDURE

__Survey Questions__

1. What factors will make air impure?

2. Under what conditions will molds form on food?

3. What is the importance of ventilation?

__Topic 1__ -- The dust in the air. (pp. 202-212)

__I. Non-living Dust__

Demonstrations

1. Is dust present in the air?
text, p. 202

2. How is dust made?
text, p. 203

Things to Do

1. Make a list of all the substances classed as non-living dust.

__II. Living Dust__

A. Pollen

What pollen-bearing flowers or weeds may cause hay fever?

B. Molds

Demonstration, text--p. 208

1. If a mold grows on food, how is the food affected by it?

2. What suggestions can you offer for keeping foods so that they will not mold?

C. Yeasts

Demonstration--What happens when yeast gets into a sweet liquid?

Dissolve a piece of yeast cake in a cupful of warm water. Stir three tablespoonfuls of molasses into this solution and pour the mixture into a liter flask, adding enough warm water to fill the flask about two-thirds full. Describe the odor of the mixture.

Insert a delivery tube through a one-hole stopper and place it in the flask. Place the other end of the delivery tube into a test tube containing limewater. Set the apparatus aside for several days. What has happened in the flask? What change has occurred in the limewater?

The gas that caused this change is carbon dioxide. Smell the liquid in the flask. The odor is due to alcohol which is now present in the liquid. The process by which the alcohol is produced is called fermentation.

D. Bacteria

Demonstration, text--p. 210

Things to Do

1. Make a chart showing the multiplication of bacteria.

2. How are bacteria helpful to man?

3. How are bacteria harmful to man?

4. How can we avoid harmful bacteria?

Topic 2 -- The need for cleanliness. (pp. 212-214)

Demonstration

Sterilize two Petri dishes--fill both about one-half full with a gelatin mixture. Place the covers on the dishes and allow to stand until the gelatin hardens. Raise the cover of one dish and gently touch the surface of the gelatin with the tips of the fingers. Lower the cover and mark the dish "Dirty Hands."

Then wash hands thoroughly with soap and water. Dry hands with a clean towel. Raise the cover of the other Petri dish and touch surface of gelatin with clean finger-tips. Lower the cover and mark this dish "Clean Hands." Set both dishes away in a warm, dark place for four days. Examine both dishes at the end of four days.

1. What do you see on the surface of the gelatin?

2. Are more bacteria found on dirty hands or on clean hands? Explain.

3. Are "clean hands" always clean?

Things to Do

1. Make a list of rules for personal cleanliness.

Topic 3 -- Dangerous gases in the air. (pp. 215-216)

1. What is the difference between carbon monoxide and carbon dioxide?

2. How is carbon monoxide produced? Why is it dangerous?

Topic 4 -- The conservation of air. (pp. 218-223)

Demonstration

1. What is a good method of ventilating a room?
   Wood and Carpenter, p. 170

Interesting Reading for Special Assignments and Reports

The Book of Popular Science:

Breathing Life and Death, II, 379-385
Disease Carried by Dust, IV, 1224
How Bacteria Aid Plants, IX, 3108-3116
Disease Carriers, XII, 4042-4052
Putting Health Facts to Work, XV, 5444-5447

Compton's Pictured Encyclopedia:

Respiration--A Breath of Fresh Air--What It Means, R, 79-80
The Good and Ill that Bacteria Do, B, 12-13
Mold and Mildews, M, 169-170
Yeast, Y, 204-205

The New Wonder World:

The Breath of Life, X, 334-340
Bacteria, X, 56
When You Had a Cold, X, 352-354
Yeast, X, 104
Food Preservation, II, 369-376

The World Book Encyclopedia:

Bacteria and Bacteriology, I, 566-569
Coryza (Common Cold) III, 1701-1702
Diphtheria, IV, 1954-1955
Influenza, or Grippe, VI, 3449-3450
Mold, VIII, 4572-4573
Scarlet Fever, X, 6409-6410
Tuberculosis, XI, 7286-7288

CONCLUSIONS

Living and non-living dust, as well as some gases that are injurious to breathing or that are unpleasant, may be present in the air as impurities.

THOUGHT QUESTIONS

1. John feels chilly in his home when the temperature is 72° F., yet is comfortable in Henry's house at 68° F. Account for this.

2. Why is it difficult to ventilate a room on a hot day unless a breeze is blowing?

3. Give three reasons why a living room should always be well ventilated.

4. What is the advantage of having groceries wrapped in sealed boxes, air-tight tins, or glass?

5. If you could, would you destroy all bacteria? Explain.

6. How can you justify the laws prohibiting common drinking cups and towels in public buildings?

7. With an old-fashioned fireplace, how was a room ventilated?

8. Name several substances besides bread on which you have seen mold.

OBJECTIVE TESTS

I

Completion

1. One kind of living dust in the air is the .... of flowers.

2. Dust may be classed as "living" and "........" dust.

3. Carbon .... is an extremely dangerous gas even in small amounts.

4. Maintaining proper air conditions is called ....

5. The pollen of certain weeds causes .... fever.

II

True-False

1. The temperature of the air in a closed room is decreased by the operation of an electric fan.

2. A well person need take no precautions against harmful bacteria because he is naturally protected against them.

3. All bacteria are harmful to man.

4. Bacteria are always present in the air.

5. Carbon monoxide and carbon dioxide are sister gases which are practically the same in origin and behavior.

III

Multiple Choice

1. Nearly all bacteria may be killed by (a) boiling; (b) salt solution; (c) cool air.

2. What is the most important reason that some manufacturers advertise that their products are "untouched by human hands"?

(a) to emphasize the attractiveness of their products;
(b) to call attention to their labor-saving machinery;
(c) to show that their products are not likely to have disease-producing bacteria.

3. The most important reason for washing the hands before touching food is to remove (a) bacteria; (b) oily excretions; (c) perspiration.

4. The process of keeping the air in a room in a comfortable, healthful condition is (a) aeration; (b) respiration; (c) ventilation.

5. The proper temperature for a classroom is (a) 58° F.; (b) 68° F.; (c) 78° F.

BOOKS FOR REFERENCE

Textbook:

Powers, Neuner, Bruner, Exploring Our World, new edition, Boston: Ginn and Co., 1946.

Caldwell, Otis W. and Curtis, Francis D. Everyday Science, Boston: Ginn and Co., 1946

Davis, Ira C. and Sharpe, Richard W. Science, New York: Henry Holt and Co., 1936.

Hunter, George W. and Whitman, Walter G. My Own Science Problems, New York: American Book Co., 1935.

Meister, Morris. Living in a World of Science, Book I
or
Water and Air, New York: Charles Scribner's Sons, 1930.

Powers, Samuel R., Neuner, Elsie F., and Bruner, Herbert B., The World Around Us, Boston: Ginn and Co., 1934.

Wood, George C., and Carpenter, Harry A. Our Environment: How We Use and Control It, Boston: Allyn and Bacon, 1940.

CHAPTER VI

PROPOSED COURSE OF STUDY IN GENERAL SCIENCE FOR GRADE VIII

Scope

According to the survey described in Chapter III, the three most common topics taught in grade VIII are:

Weather and Climate
The Heavens
Conservation of Food

These topics plus two others agreed upon by the teachers now teaching general science in grade VIII in X-city will constitute the units of work for that grade. Applying the terminology of the textbook used, the five units (minimum requirements) for grade VIII are:

The Changing Sky (The Heavens)
The Changing Air (Weather and Climate)
The Changing World of Life (Adaptation to Environment)
Our Life in a Changing World (Human Health)
Conservation in a Changing World (Conservation of Natural Resources)

The time allotment for each unit is arbitrary--however, provision should be made to complete adequately the five units outlined in this chapter.

Objectives

1. To effect an understanding of the practical value of science and the ability to practice it in everyday life.

2. To increase the pupil's knowledge, appreciation, and understanding of the outstanding features of his environment to

the end that he may deal more effectively with the everyday problems of life.

3. To develop a desire to lead a clean, hygienic life.

4. To develop a functional understanding of the major generalizations of science.

5. To teach the scientific method.

6. To develop the scientific attitudes of open-mindedness, suspended judgment, and intellectual honesty.

7. To build up a scientific vocabulary.

Outline of Minimum Course Requirements

Unit One -- The Changing Sky
(six weeks)

Principles

1. All bodies in the solar system are controlled by the gravitational attraction of the sun.

2. Two balancing forces, motion and gravitation, tend to keep the astronomical bodies in place.

3. The movements of the solar system and of the stars continue in a regular uniform motion.

4. The planets revolve around the sun in periods which vary with their distances from the sun.

5. The earth's position and relation to the sun and moon are of great importance to the life of the earth.

6. A great passing star may have pulled some of the gaseous material from our sun, thus forming the beginning of our earth, the planets, and the moon.

7. The rising and setting of the sun, moon, and stars is due to the rotation of the earth.

8. Eclipses are caused by the earth's shading the moon or by the moon's shading the earth.

9. Tides are caused by the attraction of the moon.

I. What are the stars?

   A. The North Star

   B. The Milky Way

   C. Constellations
      1. Legends
      2. Use of star maps

   D. Movement of stars

   E. Present-day knowledge of stars

II. What is the solar system?

A. The nine planets
1. Relation to the sun
2. Individual characteristics

B. Little brothers of the planets
1. Comets
2. Planetoids
3. Meteors

C. The sun
1. Size
2. Surface
3. Effect on planets
4. Energy of the sun

III. What is the moon?

A. Nature of the moon

B. Phases of the moon

C. Eclipses
1. Of the sun
2. Of the moon

D. Cause of tides
1. Kinds of tides
2. Their value to man

****

Unit Two -- The Changing Air
(eight weeks)

Principles

1. Weather varies with variations in air pressure.

2. The pressure of the atmosphere becomes less as the distance above the earth's surface becomes greater.

3. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it.

4. Evaporation follows precipitation, and precipitation follows evaporation in endless succession.

5. Differences in temperature cause differences in atmospheric pressure, and these differences in atmospheric pressure cause winds.

6. When air is cooled sufficiently, the moisture in it condenses.

7. Air moves from points of greater pressure to points of less pressure, causing air currents or winds.

I. What is the drama of the weather?

- A. How to study the weather
- B. Air, the mother of weather
  - 1. The upper air
  - 2. The lower air
- C. Heat
  - 1. The heating of air
  - 2. Heat movements
    - a. Radiation
    - b. Conduction
    - c. Convection
- D. Wind
  - 1. Nature of wind
  - 2. Belts of high and low pressure
  - 3. The prevailing winds
- E. Moisture
  - 1. Effect of moisture on air pressure
  - 2. Return of moisture to the earth
    - a. Clouds and fog
    - b. Forms of precipitation

II. How does the weatherman study the weather?

- A. Weather prophets
  - 1. False signs
  - 2. True signs
- B. Temperature
  - 1. The mercury thermometer
    - a. Construction
    - b. Uses
    - c. Scales

2. The metallic thermometer
3. The thermograph

C. Air pressure
1. The mercury barometer
2. The aneroid barometer
3. The barograph

D. Humidity
1. The dew point
2. Relative humidity
3. The wet-bulb thermometer
4. Hair hygrometers

E. The wind gauge

F. Prediction of weather

III. What is the nature of the weather in North America?

A. Cyclones and anticyclones
1. The prevailing westerlies
2. Cyclones
3. Weather maps
4. Anticyclones

B. Thunderstorms and tornadoes
1. Local storms
a. Formation of hail
b. Lightning
c. Thunder
d. The rainbow
2. Tornadoes
a. Tornadoes on land
b. Seagoing tornadoes--waterspouts
3. Hurricanes
a. The course of a hurricane
b. The treachery of hurricanes
4. Comparison of storms

IV. What is climate?

A. The effects of the earth's motions
1. Weather and climate
2. Cause of the seasons
3. Cause of day and night

B. The zones of the earth

C. The climates of the earth

1. In the torrid zone
    a. High elevation in the tropics
    b. The jungle
    c. The rain forests
    d. The ricelands
    e. The grasslands
    f. The desert lands
2. In the temperate zones
3. In the frigid zones

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Unit Three -- The Changing World of Life
(ten weeks)

Principles

1. All living things require energy in the form of food.

2. Green plants, using the energy of sunshine, make food out of water and carbon dioxide.

3. All living things are helped by the activities of some other living thing and are harmed by the activities of still other living things.

4. Living things reproduce their kind, and by this means life continues from age to age.

5. The environment causes changes in living things, and living things cause changes in the environment.

6. All living things must adapt themselves to the conditions under which they live or become extinct.

7. Certain amounts of light, heat, moisture, oxygen, and food are necessary to the life of most living things.

I. How do the changing seasons affect plant life?

A. Spring
1. The needs of green plants
    a. Warmth and sunlight
    b. Moisture
    c. Good soil
2. The sprouting of seeds

B. Summer
1. The manufacture of food by green plants
2. The fertilization of flowers
3. The production of seeds

C. Autumn
1. The season of fruit
2. The scattering of seeds
3. The cause of the falling of leaves

D. Winter
1. Survival of green plants during season
2. Effects of cold upon plant life

II. How do the changing seasons affect animal life?

A. The life cycles of
1. Frogs
2. Cold-blooded animals
3. Fishes
4. Insects
a. Housefly
b. Mosquito
c. Bumblebee
d. Butterflies and moths

B. Seasonal adaptations of
1. Migratory birds
2. Rabbits
3. Squirrels
4. Woodchucks

C. The importance of seasonal changes

III. How are plants and animals adapted for life in the desert?

A. The desert
1. Rainfall in the desert
2. Temperature in the desert
3. Death Valley

B. Adaptations of plants
1. Protection against dryness
2. Other desert adaptations
3. Study of giant cactus of Arizona

C. Adaptations of animals
1. Protection against dryness
2. Protection against heat
3. Protection against their enemies
4. Study of the horned toad and camel

IV. How are plants and animals adapted for life in the ocean?

A. The ocean life of the frigid zones
  1. The life of the Arctic region
  2. The life of the Antarctic region

B. The ocean life of the temperate zones
  1. Rocky shores
  2. Sandy shores
  3. Muddy shores

C. The ocean life of the torrid zone
  1. Sea anemones
  2. Corals and sponges
  3. The larger sea animals

D. Life in the oceans away from the shore
  1. The strange Sargasso Sea
     a. Location
     b. The mystery of the eels
  2. Life beneath the surface of the sea

V. How is man adapted for the life he leads?

A. Man's adaptations to heat and cold
  1. Natural adaptations
  2. Artificial adaptations

B. Man's adaptations to disease
  1. The health problem of civilized man
     a. The common cold
     b. Diseases resulting from colds
     c. The illnesses of summertime
  2. The need of sunshine

C. The best conditions for man
  1. The best temperature
  2. The best humidity
  3. The ideal climate

D. Other adaptations of man

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<u>Unit Four -- Our Life in a Changing World</u>
(six weeks)

<u>Principles</u>

1. All living things are composed of very small units called

cells.

2. All living things use oxygen to change food into heat and other forms of energy.

3. All living things require energy in the form of food.

4. All living things are helped by the activities of some other living things and are harmed by the activities of still other living things.

5. Efficient living is dependent upon a knowledge of the principles of health and sanitation.

6. Communicable diseases are caused by germs.

7. We are absolutely dependent upon green plants for food.

I. How do our bodies use energy?

 A. The nature of food
  1. The carbon cycle
  2. Classes of foods
   a. Carbohydrates
   b. Fats
   c. Proteins

 B. Digestion of food
  1. The machinery of digestion
   a. Mouth
   b. Stomach
   c. Small intestine
   d. Large intestine
  2. Effect of gland secretions on food

 C. The releasing of the energy of food
  1. The work of the lungs
  2. The importance of oxygen
  3. The relation of circulation to respiration
   a. The work of the blood
   b. The waste products in the blood
  4. The work of the kidneys

II. What is health?

 A. The work of a healthy body
  1. The healthy body at rest
  2. The use of oxygen during exercise

3. The regulation of body temperature
4. The regulation of glucose in the blood
5. The regulation of the circulation of the blood
6. The nervous system

B. The enemies of good health
   1. Alcohol
      a. Immediate effects
      b. Dangers in overindulgence
   2. Tobacco
      a. The case against smoking
      b. Harmful effects
   3. Drugs
      a. Harmful effects
      b. Use as medicine

C. Rules for healthful living
   1. The rules of eating
   2. The rules of cleanliness
   3. The rules of breathing
   4. The rules of body activity

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Unit Five -- Conservation in a Changing World
(six weeks)

Principles

1. The surface of the earth is constantly changing.

2. Living things are constantly striving with each other for the available supply of food.

3. The environment causes changes in living things, and living things cause changes in the environment.

4. Man has become an important determining factor in the environment of all life. His continued existence and advancement are dependent upon his wise modification and control of his environment.

I. How can we save our plant and animal resources?

   A. The need for conservation
      1. Small-scale conservation
      2. Large-scale conservation

B. The conservation of wild life
   1. The disappearance of fish
      a. Fishermen and fish
      b. The menace of barriers across streams
      c. The menace of pollution
   2. The disappearance of game
      a. Causes
      b. Protective agencies

C. The conservation of forests
   1. Our vanishing forests
   2. Forest conservation

II. How can we save our minerals and soils?

A. The conservation of metals
   1. The problem of saving our metals
   2. The use of low-grade ores

B. The conservation of fuels
   1. The conservation of coal
      a. The waste in coal-mining
      b. Methods of conserving coal now in use
   2. The conservation of petroleum
   3. The future source of power

C. The conservation of soils
   1. Our vanishing grasslands
   2. Normal and abnormal erosion
   3. The chain of disaster
      a. Deforestation
      b. The swollen streams
      c. Overplowing and overgrazing
      d. Dust storms
      e. Floods
      f. Poverty and migration
   4. Breaking the chain
      a. Reforestation
      b. Reseed dry regions
      c. Contour plowing
      d. Strip cropping
      e. Terracing
      f. Check dams
      g. Irrigation projects

Sample Unit

Unit Two -- The Changing Air

Major Generalizations

Weather varies with variations in air pressure.

There have been profound changes in the climate, not only of certain regions, but also of the earth as a whole.

Unit Objectives

1. To eliminate superstitions and ideas in regard to weather.

2. To understand the fundamental factors which cause weather changes.

3. To appreciate the fact that Weather Bureau forecasts are based upon scientific observations.

4. To show that man is capable of adjusting himself to weather changes.

Outline of Content

I. What is the drama of the weather?
   A. Methods of studying the weather
   B. Factors which make weather
      1. Air
         a. Exploring the upper air
         b. Exploring the lower air
      2. Heat
         a. Study of heat movements
         b. The endless give-and-take of heat
      3. Wind
         a. Nature of wind
         b. Belts of high and low pressure
      4. Moisture
         a. Effect on air pressure
         b. Forms of moisture in the air
            (1.) Clouds
            (2.) Forms of precipitation

II. How does the weatherman study the weather?
   A. Weather prophets
   B. Methods by which the weatherman studies

1. Temperature
   a. Instruments used
   b. Structure of thermometers
   c. Comparison of thermometer scales
2. Air pressure
   a. Instruments used
   b. Structure of barometers
3. Humidity
   a. Instruments used
   b. Computation of relative humidity
4. Wind
   a. Instruments used
   b. Structure of wind gauge

C. The prediction of weather

III. What is the nature of the weather in North America?

A. Cyclones and anticyclones
   1. Reading of weathermaps
   2. Interpreting weathermaps

B. Thunderstorms and tornadoes
   1. Local storms
   2. Tornadoes
   3. Hurricanes
   4. Comparison of storms

IV. What is climate?

A. The effects of the earth's motions on
   1. Weather and climate
   2. Seasons
   3. Day and night

B. The zones of the earth

C. Study of the different climates of the earth
   1. The torrid zone
   2. The temperate zones
   3. The frigid zones

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<u>Standards of Achievement</u>

A knowledge of the factors which determine weather conditions; procedure employed in weather forecasting--instruments used; factors which determine climate; relation of weather and climate to human activities, to health; human adaptations to weather and climate by means of shelter, clothing.

The construction and uses of thermometer, barometer, hygrometer, anemometer, etc; how to interpret weather maps and reports; how to select clothing adapted to weather conditions.

Problem I -- What is the drama of the weather?

Aims: 1. To discover the effect of heat on air.
2. To find out the effect of evaporation upon temperature and atmospheric pressure.
3. To know the different forms of precipitation.
4. To recognize the various cloud forms.
5. To learn what weather is.

Vocabulary

altitude	forecast	radiant energy
calms	humidity	radiation
cirrus	latitude	region
condensation	nimbus	stratosphere
conduction	observations	troposphere
convection	precipitation	vapor
cumulus	pressure	velocity
		weather

SUGGESTED TEACHER PROCEDURE

Preview to Unit (The references listed below are for the teacher who may wish to use the material in one or both of the books as an introduction to the unit.)[1]

Hunter and Whitman, "How the Air Influences Man's Activites," pp. 49-50.

Davis and Sharpe, "The Story of Progress and Discovery," pp. 95-96.

Survey Questions

1. Where does rain come from?

2. What causes the wind to blow?

3. Why is it possible to tell the direction of a light wind by holding up a moistened finger?

4. Why are people tired and uncomfortable on a muggy day in summer?

5. What is fog? Why do fogs usually collect about icebergs?

[1]All books referred to in this chapter are entered in the bibliography at the end of the chapter.

A. HOW TO STUDY THE WEATHER. (pp. 84-88)

Pupil Activity

Keep a daily record for a week of temperatures, wind conditions, and rainfall as suggested in text, pp. 86-88.

B. FACTORS WHICH MAKE THE WEATHER. (pp. 89-108)

Demonstrations

1. What effect does heat have on air?
Wood and Carpenter, p. 577

2. Does warm air rise?
text, p. 95

3. Does cool air sink?
text, p. 95

4. What causes winds?
Set two test tubes whose bottoms have been cut off, one at each end of a twelve-inch box having a glass side. Do not allow the test tubes to touch the bottom of the box. Place a candle in the box under one of the test tubes which we will call "B". Hold a piece of burning paper over tube A (the other tube) before the candle in tube B is lighted, and also after the candle is lighted. Watch the air currents through the glass side of the box. What effect does the lighted candle in tube B have on the temperature of the air? What is the direction of the air currents in tube B when the candle is lighted? Explain. What is the direction of the air currents in tube A when the candle in tube B is not lighted?

5. What is the effect of the earth's rotation on winds?
Snyder, p. 218

6. What factors aid evaporation?
Davis and Sharpe, p. 101

7. Can fog be produced in a flask?
Caldwell and Curtis, p. 183

8. How can one form a cloud?
text, p. 104

9. What conditions cause dew, frost, fog, rain, snow, hail, and sleet?

Fill a 200-cc. beaker about one-fourth full of cracked ice and water. Stir the mixture and watch the outside of the beaker. What forms or condenses on the outside of the beaker? Where did this moisture come from? Why did this water vapor condense on the outside of the beaker? If, for the same reason, moisture collects on grass during a summer night, what is it called?

Add two tablespoonfuls of salt to the ice and water mixture. Stir vigorously. Watch the outside of the beaker. What forms on the outside of the beaker now? What would it have been called if this substance had formed on grass during a freezing spring or fall night? How do frosts kill plant life? In a motion picture theater, what does the beam of light from the projector show floating in the air? What evidence have we that these particles are present in the air at all times? When water vapor condenses on these dust particles near the surface of the earth, what condition is produced? If this kind of condensation were to take place in the upper air, What would be formed? If the condensation were carried still farther, forming large droplets, what would be formed? If these droplets should freeze as they form or during the time they are falling, what would be produced?

Things to Do

1. Report on the air pressure on a windy day; on a quiet day. What causes the difference?

2. Make a report on wind direction and its results. Note particularly what kind of weather an east wind brings. After a rainstorm, note the wind direction and account for any change.

3. Keep a daily record of temperature, pressure of the air, direction of the wind, cloudiness, rain or snow for fourteen days.

4. Secure records of annual rainfall in your region. Prepare a table and a graph showing the amount of rainfall for each month of the year.

5. Measure rainfall after a storm. See Snyder, p. 231 for instructions.

6. Why are daily weather forecasts issued?

For a period of two weeks cut out the official weather forecasts from a daily newspaper. Paste them neatly on a large sheet of art paper and check each forecast in some way to show whether it proved to be correct or not.

a. What per cent of these forecasts are correct?

b. Why does the United States Government spend large sums of money each year to issue these forecasts?

c. What industries are anxious to get these daily forecasts?

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Interesting Reading for Special Assignments and Reports

<u>The Book of Popular Science</u>:

Water Vapor in the Air, VI, 1796-1797
Problems of Cloudland, IX, 3098-3107
Rain, IX, 3100-3104; X, 3315-3325
Snow, Ice, X, 3444-3456; XI, 3704-3705

<u>The World Book Encyclopedia</u>:

Clouds, III, 1491-1494
Fog or Mist, IV, 2505-2506
Frost, V, 2628
Hail, V, 3005-3006
Rain, X, 5984-5986
Wind, XII, 7789-7791

<u>Compton's Pictured Encyclopedia</u>:

Clouds of Different Types, C, 280-281
Rain, R, 46-48
Snow, S, 173-174
Winds, W, 112-113
Frost, F, 209-210
Fog, F, 132

<u>The New Wonder World</u>:

Winds, I, 90-92

CONCLUSIONS

The important factors composing weather are air temperature, air pressure, humidity, and air movements. Their constant action upon one another (humidity reducing evaporation and air pressure; rising temperature reducing air pressure and increasing evaporation; the relations between air pressure, temperature, and wind, etc.) results in fair or bad weather.

Moisture in the air may condense as clouds, fog, rain, dew, sleet, hail, or frost. Variations in precipitation at any one point are due to several air and land factors. The distribution of precipitation in the United States is fairly regular and of great importance to its people.

THOUGHT QUESTIONS

1. How are displays in dry goods stores varied with the weather conditions?

2. Does the weather affect your daily life? How?

3. In what ways does food supply depend upon the weather?

4. Why is it sometimes colder in valleys than on hilltops?

5. Why does fog usually disappear after the sun comes up?

6. Why is the surface of a flat hilltop likely to be hotter than the sloping sides of the hill?

7. How would you explain or demonstrate to a boy or girl of your own age that dew does not actually fall?

8. It has been reported that tadpoles, frogs, and fish have actually fallen from the air along with raindrops. Explain.

OBJECTIVE TESTS

I

Multiple Choice

1. At night much heat is lost by (a) radiation; (b) conduction; (c) convection.

2. Warm air is (a) heavier than; (b) lighter than; (c) as heavy as, cold air.

3. Nimbus clouds are (a) bright and foamy; (b) dark and threatening; (c) delicate and wispy.

4. We call the falling of condensed water vapor (a) evaporation; (b) aeration; (c) precipitation.

5. The upper air is called the (a) stratosphere; (b) atmosphere; (c) troposphere.

II

True-False

1. Weather is defined as "the condition of the lower air in a given region at a given time."

2. Conduction is the chief method that we use to heat the air in our homes in winter.

3. Wind is air in motion.

4. Heating of the air is the chief cause of condensation and precipitation.

5. "Rain" clouds are scientifically known as cumulus clouds.

\##

Problem II -- How does the weatherman study the weather?

Aims:
1. To determine true weather signs.
2. To discover how a weather map shows weather conditions.
3. To understand how to keep a weather record.
4. To appreciate the work of the Weather Bureau.

Vocabulary

barograph	dew point	saturated
barometer	evaporation	temperature
aneroid	Fahrenheit	thermograph
mercury	hygrometer	Weather Bureau
centigrade	prediction	thermometer
degrees	relative humidity	wind gauge

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SUGGESTED TEACHER PROCEDURE

Survey Questions

1. What are the signs of approaching rain?
2. From what direction does the wind usually blow before a storm?
3. Why does a very heavy dew generally mean fair weather?
4. What uses are made of weather reports?
5. What instruments are used in the study of the weather?

A. WEATHER PROPHETS. (pp. 111-114)

Pupil Activities

1. Make a collection of sayings about the weather.
2. Discuss the weather proverbs listed in Brooks, Why the Weather? Chapts., VIII and XIX. Are they true or false signs?

B. HOW THE WEATHERMAN STUDIES WEATHER FACTORS. (pp. 114-133)

Demonstrations

1. How does a thermometer show changes in temperature?
text, p. 119 or Wood and Carpenter, p. 551

2. How does heat affect a compound bar? (Use to illustrate the principles of the metallic thermometer.)
text, p. 120

3. How is a mercury barometer made?
text, p. 124

4. What is the effect of atmospheric pressure upon a mercurial barometer?
Wood and Carpenter, p. 554

5. How can you determine the dew point of the air in your schoolroom?
text, p. 126 or Davis and Sharpe, p. 101

6. How is the wet-bulb thermometer used?
text, p. 128

7. How can you determine the relative humidity of your schoolroom?

text, p. 130

8. How can the direction and velocity of the wind be determined?

Carpenter and Wood, Book II, p. 170

Things to Do

1. List all the uses of thermometers you can discover.

2. Report on the history of the development of the thermometer. See Meister, pp. 73-75 or any encyclopedia.

3. Report on the construction and use of the clinical thermometer.

4. Make a chart showing well-known temperatures given both in Fahrenheit and Centigrade readings.

5. Prepare a booklet on "How the Weatherman Studies the Weather." Illustrate it with drawings or photographs of the instruments used, the types of records kept, and such other information as you think might make your story more interesting and accurate.

6. Report on the work of Torricelli and the other scientists who devised instruments to measure air pressure.

7. Measure the rainfall after a storm. See Hunter and Whitman, p. 83 for instructions.

8. Look up some of the weather charts issued by the United States Weather Bureau and note the differences recorded in barometric pressures in different parts of the United States. Try to find some reasons for these differences.

9. Compare weather predicting in early times with that at the present time. If there is a difference, what part has science taken in bringing it about?

10. Make your own weather station. See Smith for directions to make the following instruments:

wet-and dry-bulb thermometer ...p. 118
chemical weather glass ....p. 120
floral barometer ....p. 119
wind vane.......................p. 115
anemometer ....p. 116

Interesting Reading for Special Assignments and Reports

The Book of Popular Science:

The Weather Mystery, XI, 3699-3708
Modern Weather Wisdom, XIII, 4542-4553

The World Book Encyclopedia:

Dew, III, 1925-1926
Humidity, V, 3285-3286
Hygrometer, VI, 3314-3315
Thermograph, XI, 7144
The Story of the Weather Bureau, XII, 7686-7692

Compton's Pictured Encyclopedia:

Weather Bureau, W, 48
Hygrometer, H, 375

The New Wonder World:

Weather Bureau, X, 247

CONCLUSIONS

The United States Government through the United States Weather Bureau has been studying the weather scientifically and making daily forecasts for many years. The data submitted to the Bureau by each observation station includes barometric pressure, thermometer reading, and the velocity and direction of the wind.

THOUGHT QUESTIONS

1. It is important that shippers of fruit and vegetables receive weather forecasts. Why?

2. How do bodies of water like the Great Lakes affect the temperature of the surrounding regions in summer? in winter?

3. Why does a barometer give the same reading indoors as outdoors?

4. Why is it difficult to maintain a relative humidity of from forty to sixty per cent in our homes during cold weather?

5. Henry observed that the barometer was falling. What

general weather prediction might he make from his observation?

6. When Helen was at the seashore, she noted that there was a "sea breeze" by day and a "land breeze" at night. Explain.

7. Why is the "sweating" of a pitcher of ice water on a hot day similar to the visibility of your breath on a cold day?

8. State a weather proverb or saying that you have heard or used frequently. Does it have a scientific basis? Explain.

OBJECTIVE TESTS

I

Multiple Choice

1. If it rains on St. Swithin's Day (a) more rain will follow; (b) less rain will follow; (c) one cannot tell about the rain to come.

2. Evaporation is increased when the humidity is (a) increased; (b) decreased; (c) more than one hundred per cent.

3. A barometer measures the (a) density; (b) pressure; (c) depth of the air.

4. The instrument used to measure the humidity of the air is the (a) barometer; (b) thermometer; (c) hygrometer.

5. The most important instrument the weatherman uses in predicting the weather is the (a) thermometer; (b) telescope; (c) barometer.

II

True-False

1. The temperature at which moisture begins to condense as dew is called the dew point.

2. Evaporation requires heat.

3. Most liquids expand when cooled and contract when heated.

4. The predictions of the Weather Bureau are based on the laws of science.

5. Weather proverbs or sayings are accurate and should be relied upon.

III

Write R after each of the following that is likely to be a correct forecast of Rain. Write S after those that are Superstitious forecasts. Write N for those that do Not forecast rain.

1. Wind from the east or southeast.
2. Tilted crescent moon.
3. Increasing relative humidity.
4. Red sky in the morning.
5. Heavy dew on the grass.
6. Rising temperature and falling barometer.
7. Rising barometer and falling temperature.
8. Gray sunset.
9. Halo around the moon.
10. The singing of crickets.

##

Problem III -- What is the nature of the weather in North America?

Aims: 1. To foster the understanding that weather forecasts are based upon accurate scientific information that is correct ninety per cent of the time.
2. To develop the ability to read and interpret weather maps.
3. To develop an understanding of the different kinds of storms.

Vocabulary

anticyclone	isobar	snow
conductor	isotherm	thunder
cyclones	lightning	tornadoes
hail	low pressure area	typhoon
high pressure area	prevailing westerlies	waterspout
hurricane	rainbow	

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. How does the temperature usually change during and after a storm?

2. Why is a person more likely to be struck by lightning in an open field than when standing in the woods?

3. Explain why thunder causes a house to shake.

4. What is the difference between a tornado and a hurricane?

5. Mention several helpful effects of wind you have personally noticed; several destructive.

Topic 1 -- Cyclones and Anticyclones. (pp. 136-143)

Things to Do

1. How does a weather map predict the weather?
   text, p. 139

2. How are conditions in an anticyclone determined?
   text, p. 142

3. Try to secure one week's recording of a barograph. What air pressure conditions are shown on the graph?

4. Demonstration--How is a storm center formed?
   Wood and Carpenter, p. 569

Topic 2 -- Thunderstorms and Tornadoes. (pp. 143-152)

Demonstrations

1. What makes lightning?
Carpenter and Wood, Book II, pp. 189-193 (several demonstrations and explanations)

2. What does the reduction of air pressure do to a corked bottle?
text, p. 151

3. Use a prism to cast the solar spectrum on a wall in the classroom. Explain how raindrops act as prisms to form a rainbow.

Things to Do

1. How accurate are weather predictions?
Davis and Sharpe, pp. 111-112

2. Thunderstorms. Use Westinghouse pamphlets[2] for discussion. These pamphlets are free and are available in quantity.

3. Make a list of precautions to be observed during a thunderstorm. Give a reason for each rule.

4. Tell in your own words the story of the typhoon described by Joseph Conrad in his adventure story "Typhoon."

5. Discuss the conditions which exist in the belt of equatorial calms as described in Joseph Conrad's story "The Mirror of the Sea."

Topic 3 -- Hurricanes. (pp. 152-158)

Things to Do

1. Compare thunderstorms, hurricanes, and tornadoes.

2. Discuss the New England Hurricane of 1938. Have pupils bring illustrated material for bulletin board on above topic.

[2] See the bibliography at the end of this chapter for titles.

Interesting Reading for Special Assignments and Reports

The Book of Popular Science:

Artificial Lightning, XV, 5503-5508

The World Book Encyclopedia:

Blizzard, II, 794
Cyclone, III, 1796
Hurricane, V, 3296
Isobars, or Isobaric Lines, VI, 3567-3568
Isothermal Lines, or Isotherms, VI, 3568-3569
Lightning, VII, 4001-4004
Storms, XI, 6851
Tornado, XI, 7212-7213
Trade Winds, XI, 7235-7236
Waterspouts, XII, 7674-7675

Compton's Pictured Encyclopedia:

Storms, S, 298-299
Waterspouts, W, 52
Cyclones--Hurricanes and Typhoons, C, 418

The New Wonder World:

Thunder and Lightning, I, 110-112
Storms and Cyclones, I, 178-185

CONCLUSIONS

The variation of many weather factors over small areas often results in local thunderstorms and tornadoes while in large areas there develop storm centers called cyclones and anticyclones, which result in high-and low-pressure areas moving across the United States from the northwest to the southeast and northeast.

THOUGHT QUESTIONS

1. Why do we have hail storms in hot weather?

2. Where are the places of greatest rainfall in the United States?

3. Describe the wind and cloud conditions of a thunderstorm.

4. Upon what does the rainfall of a place largely depend?

5. Why are storm centers called "lows?"

6. Would it be possible to have a low-pressure area without a corresponding high-pressure area?

7. The Weather Bureau states that winds have a tendency to blow from highs to lows. Explain why this is so.

8. What is the cause of lightning? of thunder?

OBJECTIVE TESTS

I

Multiple Choice

1. A line on a weather map connecting points of equal air pressure is an (a) isotherm; (b) isobar; (c) isogon.

2. As an anticyclone approaches, the barometer (a) falls; (b) rises; (c) remains the same.

3. Cumulus clouds bring (a) frosts; (b) rains; (c) blizzards.

4. A downward moving air current will form the center of (a) a cyclone; (b) an anticyclone; (c) a hurricane.

5. Houses within a tornado are destroyed because of the (a) greater; (b) smaller; (c) lack of air pressure in them.

II

Select from the following list of words those which best fill the blank spaces in the sentences below and arrange them in the proper numerical order. The same word may be used more than once.

clouds	electricity	damage	air
saturated	colder	lightning	local
cyclonic	moist	temperature	warmer
precipitation	energy	sun	tornadoes

The (1) ..... provides the atmosphere with (2) ....., which produces in various ways winds, clouds, and storms. Thunderstorms and (3) ..... are two types of (4) ..... storms which do much (5) ..... . A discharge of (6) ..... through the (7) ....

is called (8) ..... and produces thunder. Our common periodic storms are (9) ..... storms. In a low barometric area the air is (10) ....., light and warm. It is in this area that we have (11) ..... and (12) ..... .

###

Problem IV -- What is climate?

Aim: To understand the relation between weather and climate.

Vocabulary

boundaries	grasslands	tropic of Capricorn
climate	jungle	tundra
desert	orbit	vegetation
earth's axis	perpendicular	vertical
equator	ricelands	zenith
equinox	tropic of Cancer	zone

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. Which affects our lives more, weather or climate?

2. How are deserts formed?

3. The climate of the temperate zone, including most of the United States, has been called an "energetic climate." Do you think this is so? Do you know some differences between the climate of the United States and those of other regions, such as the Congo or the Arctic? Why might not these other regions also be said to have an energetic climate?

4. How does climate affect plant life, animal life, industry, and occupations?

Things to Do

1. Demonstration--What is the influence of water upon climate?
Hunter and Whitman, p. 77

2. List some ways in which animals prepare for winter.

3. Compare the climate of your community with that of other communities and with other countries.

4. Compare the good and bad features of the climate in which you live.

5. How are the industries of your community related to weather and climate?

6. What adaptations do plants, animals, and men make to weather and climate?

7. Make a detailed study of a hot country: its location with reference to North America, Europe, and Asia; the trade routes by which it may be reached; the influence of its location with respect to prevailing winds; its position on its continent; its nearness to the ocean; its plant and animal life and how these are fitted for their environment; and the life, progress, and industries of its people.

8. Make a similar study of a cold country.

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Interesting Reading for Special Assignments and Reports

The World Book Encyclopedia:

Chinook, III, 1402-1403
Climate, III, 1482-1483

The New Wonder World:

Weather Distinguished from Climate, I, 96-99
Byrd's Observations in Antarctic, IV, 213-214

Use a World Atlas or a geography textbook for the following:

1. How can you account for the fact that the climate of Mexico City, which is in the Torrid Zone, is so much cooler than that of Miami, Florida, which is farther from the equator?

2. Why does the region just south of the Himalaya Mountains in India have the greatest annual rainfall in the world? What effect has this rainfall on the type of vegetation in this area?

3. What is the climate of the Sahara Desert? How does this affect the habits of the people?

4. In what ways does the climate of the arctic affect the living habits of the Eskimos?

CONCLUSIONS

The types of plants and animals and the living conditions of man are very decidedly influenced by large bodies of water, prevailing winds, altitude, distance from the equator, and the amount of rainfall. All these factors, together with the average weather conditions of a region taken over periods of time, are called climate.

THOUGHT QUESTIONS

1. What is the effect of mountains upon climate?

2. How do large bodies of water affect the climate along their shores?

3. Today's weather is quite different from that of last (same date of previous year). Has the climate changed? Explain.

4. State one effect of each of the following on climate: (a) altitude; (b) latitude; (c) prevailing winds; (d) neighboring bodies of water; (e) slope of land. Give reasons.

5. What is the cause of the Great American Desert?

6. What conditions influence climate, and in what ways?

7. It has been suggested as a possibility that another great lake might be made by damming the Red River of the North. If this were done, what would be the probable effect upon the winters in North Dakota?

8. How do climatic conditions affect human progress?

OBJECTIVE TEST

Select from the following list of words those which best fill the spaces in the sentences below and arrange them in the proper numerical order. The same word may be used more than once.

energetic	constant	snow	stimulating
changes	climate	colder	harmful
latitude	warmer	nearness	weather
water	faster	altitude	depressing

The (1) ..... of a place largely determines the activities carried on there. Climate depends chiefly upon (2) ....., (3). ....., and (4) ..... to large bodies of water. Land breezes result from the land cooling (5) ..... than the (6) ....., but a sea breeze comes when the land is (7) ,...... than the adjoining body of water. A climate, with moderate (8) ...... in temperature, is (9) .... The most (10) ...... people are found in the north temperate zone.

BOOKS FOR REFERENCE

Textbook:

Powers, Neuner, Bruner, and Bradley, Our World Changes, Boston: Ginn and Co., 1940.

Brooks, Charles Franklin, Why the Weather? New York: Harcourt, Brace and Co., 1935.

Caldwell, Otis W., and Curtis, Francis D., Everyday Science, Boston: Ginn and Co., 1946.

Carpenter, Harry A. and Wood, George C., Our Environment: How We Adapt Ourselves to It, Boston: Allyn and Bacon, 1937.

Clement, Arthur G., Collister, Morton C., Thurston, Ernest L., Our Surroundings, Syracuse, N.Y.: The Iroquois Pub. Co., 1928.

Davis, Ira C. and Sharpe, Richard W., Science, New York: Henry Holt and Co., 1936.

Hunter, George W. and Whitman, Walter G., Science in Our World of Progress, New York: American Book Co., 1935.

Luckiesh, Matthew, The Book of the Sky, New York: E.P. Dutton and Co., Inc., 1933.

Powers, Samuel Ralph, Neuner, Elsie Flint, and Bruner, Herbert Bascom, The World Around Us, Boston: Ginn and Co., 1934.

Smith, Edith Lillian, Everyday Science Projects, Boston: Houghton Mifflin Co., 1925.

Snyder, William H., Everyday Science, Boston: Allyn and Bacon, 1919.

Free Westinghouse Pamphlets[3]

"Man's Heritage of the Skies"--No. 2 in Little Science Series
(The ways of weather and climate and how they reach into our daily lives.)

"Today's Ben Franklins" No. 10 in Little Science Series
(What we know about lightning and why we study it.)

[3] Address: School Service
Westinghouse Electric and Manufacturing Co.
306 Fourth Avenue, P.O. Box 1017
Pittsburgh 30, Pennsylvania

CHAPTER VII

PROPOSED COURSE OF STUDY IN GENERAL SCIENCE FOR GRADE IX

Scope

According to the survey described in Chapter III, the five most common topics taught in grade IX are:

Heat
Light
Magnetism and Electricity
Preservation of Health
Life on the Earth

Nine units will be outlined in this chapter--they will include the first four topics listed above but the fifth one is eliminated because it was developed for grade VIII. The additional topics were selected by the teachers of general science in grade IX of X-city. The nine units (minimum requirements) are:

Matter, Energy, and Work
How Air Works for Man
Air, Fire, and Living Things
Water and Its Work
Bacteria
The Sources and Control of Heat
Our Use and Control of Light
Magnetism and the Work of Electricity
Human Health

The time allotment for each unit is flexible. No arbitrary time allotment has been assigned to the last unit Human Health as there is no need to have continuity in the study of its topics. In order to maintain interest and to stress the importance of physical health throughout the school year, each phase

may be developed as a separate unit.

Objectives

1. To train the pupil in the use of the scientific method of determining and solving environmental problems.

2. To furnish the pupil with a working knowledge of specific situations in which scientific facts and laws related to and employed in the world's work apply, to the end that he may fully understand and appreciate the value of science to the community and to civilization.

3. To assure in the pupil a practical knowledge of both personal and community hygiene to the end that he may practice the one and co-operate intelligently in maintaining the other.

4. To create an interest in the special sciences given in the senior high school.

5. To develop an appreciation of the work of scientists.

6. To instill an interest in scientific literature.

7. To encourage pupils to find recreational and vocational interests in science.

Outline of Minimum Course Requirements

Unit One -- Matter, Energy, and Work
(three weeks)

Principles

1. All living things must adapt themselves to the conditions under which they live or become extinct.

2. Every cause has its effect; every effect has its cause.

3. All matter is either a solid, a liquid, or a gas.

4. All matter is made up of tiny particles called molecules and these molecules are in constant motion.

5. When a solid changes to a liquid, and a liquid to a gas, heat is absorbed, and conversely.

6. Every body has weight and occupies space.

7. Gravity gives objects weight.

8. Any substance that will turn black and char when burned is organic matter.

9. A body at rest remains at rest and a body in motion remains in motion unless acted upon by some external force.

10. No two objects can occupy the same space at the same time.

11. One kind of energy can readily be changed into other kinds.

12. Energy and matter can neither be created nor destroyed but may be transformed from one form to another.

13. A machine is a device to enable man to do his work more advantageously.

14. Machines, no matter how complicated, may be analyzed into a few simple types.

15. There is always friction whenever work is done and this friction produces heat.

16. When energy is doing something, it is active or kinetic.

I. How much do you know about your surroundings?

A. Factors of environment
   1. Natural
   2. Artificial

B. Adaptation to environment

C. Relation of knowledge to environment
   1. Knowledge and its uses
   2. Superstition versus science

D. Acquisition of knowledge
   1. Observation
   2. Authority
   3. Experimentation (use of scientific method)

E. Man's workshop--the environment
   1. Raw materials
   2. Tools

II. What is matter?

A. Definition

B. Classification
   1. Kinds
   2. Forms or states

C. Properties
   1. General
   2. Special

III. What is the relation of matter to energy?

A. Man and matter

B. Matter and energy
   1. Definition of energy
   2. Classification of energy
      a. Forms
      b. Kinds
      c. Changes in forms

IV. What is the relation of matter to work?

A. Definition of work
   1. Measurement of work
   2. Obstacles to work
      a. Weight
      b. Friction
      c. Inertia

B. Common aids to labor
   1. Simple machines
   2. Compound machines
   3. Function of machines
   4. Law of machines
   5. Efficiency of machines

****

Unit Two -- How Air Works for Man
(four weeks)

Principles

1. The earth and its life are greatly affected by the ocean of air which completely surrounds it.

2. Matter is anything that occupies space.

3. Air has weight on account of the pull of the earth's gravity.

4. Air and other gases tend to expand until they occupy all portions of the containing vessel.

5. The pressure of the atmosphere decreases as the altitude increases, and increases as the altitude decreases.

6. The atmosphere exerts pressure on every surface it touches.

7. The suction of an air pump produces a partial vacuum in a cylinder.

8. Sounds are produced by vibrations and are carried by solids, liquids, and gases that vibrate.

9. Sounds travel in waves.

10. Sounds may be musical or may be mere noise.

11. The more rapidly a body vibrates, the higher is its pitch.

I. What is air?

   A. Air, a form of matter

   B. The air ocean

   C. The weight of air

II. How may air be made to work for us?

A. Measurement of air pressure
1. Barometer
a. Kinds
(1.) Mercurial
(2.) Aneroid
b. Relation to weather

B. Applications of air pressure
1. Lift pump
2. Siphon
3. Vacuum cleaner

C. Applications of compressed air
1. Force pump
2. Caisson

III. What is the relation of air and sound?

A. Differences in sounds due to
1. Pitch
2. Loudness
3. Quality

B. The speed of sounds

C. Musical instruments
1. String
2. Wind
3. Percussion

D. The ear
1. Structure
2. Function of each part
3. Hygiene of the ear
4. Aids and obstacles to hearing in the home

****

Unit Three -- Air, Fire, and Living Things
(four weeks)

Principles

1. The earth and its life are greatly affected by the ocean of air which completely surrounds it.

2. Oxidation is the reaction between oxygen of the air and other substances.

3. Matter can be changed in form but cannot be created or destroyed.

4. Chemical and physical changes are manifestations of energy.

5. A physical change is one which changes the shape or appearance of something but does not change the materials of which it is made.

6. A chemical change is a change in which a new substance is formed.

7. Some chemical changes are helpful; some are harmful.

8. Every substance is an element, a chemical compound, or a mechanical mixture.

9. There are fewer than one hundred elements.

10. One kind of energy can readily be changed into other kinds.

11. Things gain in weight when they burn.

12. When anything burns, oxygen is used and carbon dioxide is given off.

13. Combustion will not take place without oxygen.

14. All living things are composed of very small units called cells.

15. Species have survived because by adaptations and adjustments they have tended to become better fitted to the conditions under which they live.

16. Life is dependent upon certain materials and conditions.

17. Warm air is lighter than cold air.

I. What makes a fire burn?

   A. The relation between air and fire

   B. The composition of air

   C. Kindling temperatures

D. Oxidation
   1. Definition
   2. Kinds
      a. Slow
      b. Rapid
   3. Control of oxidation

E. Physical and chemical changes

F. Elements and compounds

II. How is oxidation used and controlled in the home?

A. Matches
   1. History
   2. Construction

B. Importance of fire in the home

C. Slow oxidation in the home
   1. Causes
   2. Prevention

III. Do living things burn?

A. Air and living things

B. Respiration
   1. Organs of respiration
   2. Structure of a cell
      a. Oxidation within cells
      b. Tissues and organs
   3. Man's respiratory system
      a. Organs of respiration
      b. Methods of breathing
   4. Man's circulatory system
      a. Organs of circulation
      b. Function of each
      c. Relation to respiratory system

IV. What is the meaning and importance of ventilation?

A. Meaning of ventilation
   1. How to ventilate a room
   2. The importance of ventilation
      a. The need for ventilation
      b. Impurities in the air

B. Method of ventilation
   1. The window-gravity plan
   2. Artificial ventilation

Unit Four -- Water and Its Work
(three weeks)

Principles

1. Water exists in three states: solid, liquid, and gaseous.
2. Water exerts pressure because of its weight.
3. The pressure under water becomes greater as the distance below the surface becomes greater.
4. Running water always seeks a lower level.
5. Water tends to flow from regions of greater pressure to regions of lower pressure.
6. Warm water is forced upward by the falling or settling of colder water.
7. When water evaporates, an invisible gas is formed.
8. Heat hastens evaporation.
9. Heat taken away from water vapor causes it to condense.
10. Evaporation follows precipitation, and precipitation follows evaporation, in endless succession.
11. Water in nature is never absolutely pure, but contains some dissolved substances and some other substances which will not dissolve in it.
12. Dissolved material can be removed from a liquid by distillation.
13. Undissolved material suspends in water and may be removed by sedimentation or by filtering.
14. Water is a universal solvent.

I. Water, A necessity of life

   A. Forms and properties of water

   B. The sources of water

C. The water cycle
   1. Evaporation
   2. Condensation
   3. Precipitation

II. How is water supplied to the house?

A. Storage sources

B. The house water system

III. What are some of the uses of water in the home?

A. Our dependence upon water

B. The nature of a solution
   1. Water--the universal solvent
   2. Solubles and insolubles

C. "Hard" and "soft" water

D. The effect of water on foods

E. The hot-water heater

F. Manufacture of ice
   1. Ice plants
   2. The electric refrigerator

IV. What are the methods of waste removal?

A. Cesspool

B. Septic tank

V. The community water supply

A. Sources of water supply

B. Construction of dams

C. Methods of water supply
   1. Simple gravity system
   2. Pumping system
   3. Gravity and pumping system

D. Dangers in the water supply

E. Methods of obtaining pure water
   1. Boiling

2. Distilling
3. Filtering

F. Study of local water system
1. Sources of water
2. Methods of purifying
3. Distribution

G. Forests and community water supply

H. Relation between the sun and our water supply

VI. Sewage disposal

A. The problem of sewage disposal

B. Sewage disposal plants

****

Unit Five -- Bacteria and Tuberculosis
(three weeks)

Principles

1. All living things use oxygen to change food into heat and into other forms of energy.

2. All living things require energy in the form of food.

3. All living things are helped by the activities of some other living things and are harmed by the activities of still other living things.

4. The body has natural defenses against germs.

5. Decaying food promotes the growth of bacteria.

6. Bacteria reproduce rapidly where there is warmth, moisture, and food.

7. Decay of food is caused by bacteria and molds.

8. Excessive heat kills organisms.

9. If some kinds of germs enter a cut or wound, infection may follow.

10. Public and private health is not possible without the co-

operation on the part of individuals.

I. Bacteria

A. Classes
1. Saprophytes
2. Parasites

B. Forms
1. Coccus
2. Bacillus
3. Spirillum

C. Disease Bacteria
1. Conditions favorable for growth
2. Conditions unfavorable for growth
3. Means of entering body
4. Body's natural defenses
5. Methods of preventing spread of disease
a. Immunity
b. Quarantine
c. Fumigation
d. Use of disinfectants

D. Bacteria useful to man
1. Bacteria in food manufacture
2. Bacteria in leather and linen manufacture
3. Bacteria as scavengers
4. Bacteria and fermentation
5. Bacteria and soil fertility

II. Tuberculosis

A. Nature of the disease
1. Cause of the disease
2. Age groups affected
3. Different forms of tuberculosis
4. Spread of the disease
a. Human sources of infection
b. Animal sources of infection
5. Symptoms
6. Natural resistance to tuberculosis

B. Methods of detection and treatment
1. Detection of tuberculosis
a. Case history
b. Physical examination
c. Laboratory tests

d. Tuberculin test
e. X-ray
2. Treatment of tuberculosis
a. General treatment
(1.) Rest
(2.) Proper food
(3.) Outdoor air
b. Sanatorium treatment
(1.) Hygienic regimen
(2.) Surgical aids
(3.) Education
(4.) Rehabilitation

****

Unit Six -- The Sources and Control of Heat
(three weeks)

Principles

1. Heat is a form of energy released by the oxidation of fuels.

2. Heat may be transferred by conduction, convection, and radiation.

3. Radiators expose large surfaces to the air and permit the transfer of heat to the air.

4. Some materials are good conductors, others are poor conductors or insulators.

5. Non-conductors or insulators are used to prevent the loss of heat.

6. Heat is required to change a liquid to a gas.

7. In general, bodies expand when heated and contract when cooled.

8. Whenever two bodies having different temperatures are in contact, the warmer body gives some of its heat energy to the colder one.

9. Electrical energy can be transformed into heat energy.

10. All substances have their own specific boiling point, freezing point, and kindling temperature.

11. Dark-colored, rough, or unpolished surfaces absorb radiant heat energy more rapidly than light-colored, smooth, or polished surfaces.

I. What is heat?

A. Heat, a form of energy

B. Sources of heat

C. Heat and molecular motion

D. Kinds of heat
1. Sensible heat
2. Latent heat
3. Heat of vaporization

II. How is heat distributed?

A. Conduction
1. Heat conductors
2. Heat insulators

B. Convection

C. Radiation

III. How is heat measured?

A. Temperature
1. Unit of measurement
2. Instrument of measurement
a. Structure
b. Comparison of Fahrenheit and Centigrade scales

B. Heat measurement
1. Units
a. Calorie
b. British Thermal Unit
2. Instrument

IV. What is the nature of a fuel?

A. Definition of a fuel

B. Classes of fuels

C. Coal production and supply

D. Petroleum and gas

V. How is heat distributed and controlled?

A. The use of heat in the home
   1. Kinds of cook stoves
   2. Early methods of heating homes
   3. Modern heating systems
      a. The hot-air system
      b. The hot-water system
      c. The steam-heating system
   4. The hygiene of heating--use of humidifiers

VI. How are fire dangers controlled in the home?

A. The control of fire in the home.

B. The fire extinguisher
   1. Construction
   2. Use

C. Rules for an emergency

****

<u>Unit Seven -- Our Use and Control of Light</u>
(four weeks)

<u>Principles</u>

1. The sun is the source of almost all the energy available on the earth.

2. Light is indispensable to life. The phenomena that have been discovered concerning light and the applications that have been made are important to man's continued progress.

3. Light travels in straight lines at a velocity of 186,000 miles a second.

4. When light strikes an opaque object, a shadow is formed behind the object.

5. When light strikes a surface, part of it is reflected from the surface.

6. Light rays are bent as they pass from one transparent substance into another.

7. Some objects give off light of their own, while some are seen only by reflected light.

8. We see objects when light from those objects enters our eyes.

9. Dark-colored, rough, or unpolished surfaces absorb light more rapidly than light-colored, smooth, or polished surfaces.

10. When light rays from an object pass through a small hole against a screen of some kind, an inverted image of the object is formed.

11. White light is a mixture of colors.

I. What is light?

 A. Our dependence upon light

 B. Speed of light

 C. Shadows
  1. Cause
  2. Parts

II. How do we use and control sunlight?

 A. The control of daylight in the home
  1. Transparent media
  2. Translucent media
  3. Opaque media

 B. Reflected light
  1. Use of lenses
  2. Types of lenses
   a. Converging
   b. Diverging

 D. Production of color

III. How does a camera use light?

 A. The parts of a camera

 B. Projection machines

IV. How is the human eye fitted to use light rays?

A. The structure of the eye

B. Accommodation of the eye

C. Defects of the eye
   1. Causes
   2. Correction

D. Hygiene of the eye

V. How is artificial light produced and controlled?

A. Brief history of illumination

B. The candle

C. The kerosene lamp

D. The gas flame and mantle

E. The incandescent lamp
   1. Principal parts
   2. Work of Edison
   3. Kinds of modern lamps

VI. How is light measured?

A. Instrument used

B. Units
   1. Foot-candle
   2. Watt

VII. What is the best use of light in the home?

A. Relative costs of light
   1. Determining factors
   2. Reading of electric meter

B. Kinds of lighting
   1. Direct
   2. Semi-direct
   3. Indirect

****

Unit Eight -- Magnetism and the Work of Electricity
(six weeks)

Principles

1. Like electrical charges repel each other, and unlike electrical charges attract each other.

2. Magnetic poles of the same kind repel each other, and magnetic poles of the opposite kind attract each other.

3. An electrical current may be produced in three ways: by rubbing, or friction; by chemical action; and by the use of magnets.

4. The application of electricity and magnetism in the home and in industry have revolutionized the methods of living of many peoples.

5. Electrical energy can be transformed into mechanical energy.

6. The larger the wire, the less the resistance will be to a current.

7. Electrical current is used to produce heat or light and to produce motion in an electric motor.

8. The strength of an electrical current can be regulated by changing the voltage and the resistance of the circuit.

9. When a coil of wire is made to cut through lines of magnetic force, a current of electricity is produced in the wire.

10. Whenever electrical currents flow through conductors, some of the electrical energy is changed to heat energy, and sometimes some of it is changed to light energy.

11. All matter is probably electrical in structure.

12. The earth acts as a huge magnet with magnetic poles.

13. Lightning is static electricity.

14. There are only a few metals that can be magnetized or that can be attracted by a magnet.

15. Electrical energy can be measured.

16. Neutral bodies become charged electrically upon gaining electrons or upon losing electrons.

17. The characteristics of an electrical current may be changed by a device called a transformer.

18. Electricity is believed to consist of negative particles called electrons and positive particles called protons.

19. Electrical energy is produced only at the expense of some other kind of energy.

20. Every wire carrying an electrical current is surrounded by lines of magnetic force.

I. What are magnets and how do they work?

- A. Kinds of magnets
- B. Properties of magnets
- C. Law of magnetic poles
- D. Theory of magnetism
- E. Magnetic field

II. What is electrical energy?

- A. The electron theory
- B. Charges of electricity
- C. Kinds of electricity
    1. Frictional or static
    2. Current or dynamic

III. How are electrical and chemical energy related?

- A. The simple cell
    1. Electrodes
    2. Electrolyte
- B. The dry cell
    1. Structure
    2. Uses

C. The storage cell
   1. Structure
   2. Uses
   3. Care of
   4. Comparison with dry cell

D. Electroplating
   1. Materials needed
   2. Method used
   3. Purposes

IV. How are electrical and mechanical energy related?

A. Electromagnetism
   1. Discoveries of Oersted
   2. Discoveries of Henry

B. The electromagnet
   1. Essential parts
   2. Applications
      a. Electric doorbell
      b. Telegraph sounder
      c. Telephone receiver

C. Electromagnetic induction
   1. Discovery of Faraday
   2. The electric generator or dynamo
      a. Structure
      b. Function of commutator
   3. The electric motor
      a. Relation to the dynamo
      b. Structure of a simple motor

V. How may electrical energy be controlled?

A. Making and breaking electric circuits

B. Importance of fuses

C. The electric arc

VI. How is electric current measured?

A. The measurable qualities of an electric current

B. Units of electrical measure

****

Unit Nine -- Human Health[1]

Principles

1. All living things require energy in the form of food.

2. All living things use oxygen to change food into heat and into other forms of energy.

3. We need a variety of food.

4. Foods come from plants, animals, and inorganic matter.

5. Foods are used for growth, energy, and regulation of the bodily activities.

6. Vitamins are essential to life.

7. Food must be digested before it can be used by the body.

8. Bones act as levers while muscles exert power and give us movement of the body machine.

9. The nervous system controls the human machine.

10. Bones are adapted to special uses.

11. Digestion consists of transforming foods into a liquid form so that they may be absorbed by the blood stream and then the cells.

I. Muscles

   A. Value of muscles

   B. Kinds of muscle tissue
      1. Voluntary
      2. Involuntary
      3. Cardiac

   C. Characteristics of muscle tissue
      1. Irritability
      2. Contractility
      3. Tonicity

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[1]This unit does not include those topics pertaining to human health that have been developed in previous units. No time allotment has been given as this unit is not to be taught as one main bloc of work as the preceding units. It is the author's intent that the topics be developed individually during the course of the school year.

D. Antagonistic muscles

E. Hygiene of muscles
   1. Physical exercise to develop nerve-muscle mechanism
   2. Physical exercise to correct defects

II. Bones

A. Structure of the bones

B. Composition
   1. Mineral substances
   2. Organic matter

C. The human skeleton
   1. Functions
   2. Divisions
   3. Names and locations of major bones

D. Foods necessary for the development of bones

E. Connections between the bones--joints
   1. Classification
      a. Immovable
      b. Slightly movable
      c. Movable
   2. Movement at joints
      a. Gliding
      b. Angular
      c. Rotation

III. Posture

A. Value of good posture

B. Correct posture
   1. Standing
   2. Walking
   3. Sitting
   4. Lying

C. Factors influencing bad posture

IV. Teeth

A. Structure
   1. Root
   2. Crown
   3. Neck

B. Different kinds
   1. Incisors
   2. Canines
   3. Premolars
   4. Molars

C. Temporary teeth

D. Development of permanent teeth

E. Causes of tooth decay

F. Care of permanent teeth
   1. Proper diet
   2. Proper methods of brushing
   3. Visit dentist regularly

V. Foods

A. Our needs for food
   1. Provide materials for growth
   2. Replace worn-out tissue
   3. Provide energy

B. Classes of food
   1. Fuel foods
      a. Carbohydrates
      b. Fats
   2. Building foods--proteins
   3. Minerals
   4. "Body-regulators"--vitamins

C. Importance of milk
   1. Grades of milk
   2. Pasteurization

D. A balanced diet

E. Methods of preserving food
   1. Dehydrating
   2. Canning
   3. Refrigeration
   4. Salting and smoking
   5. Food preservatives

F. Food substitutes and adulterants

G. Pure-food-and-drug laws

VI. Digestive system

A. Processes involved in use of food by the body

B. Digestive organs
   1. Mouth
      a. Accessory organs
      b. Enzymes
   2. Stomach
      a. Location
      b. Function
      c. Digestive juices
      d. Effect upon food
   3. Small intestine
      a. Location
      b. Accessory organs
         (1.) Work of each
         (2.) Enzymes produced
      c. Absorption of products of digestion
   4. Large intestine
      a. Location
      b. Function

VII. Nervous system

A. Divisions
   1. Brain
      a. Cerebellum and its functions
      b. Cerebrum and its function
   2. Spinal cord
      a. Nerve movements
         (1.) Voluntary
         (2.) Involuntary
      b. Composition of nerve tissue
      c. Reflex action
   3. Sympathetic nervous system
      a. Functions
      b. Importance

B. Diseases of nervous system
   1. Meningitis
   2. Infantile paralysis
   3. Neuritis

C. Conditions for a healthy nervous system
   1. Rest
   2. Fresh air and sunlight
   3. Wholesome diet
   4. Peaceful mind

Sample Unit

Unit Eight -- Magnetism and Electricity

Major Generalization

The application of electricity and magnetism in the home and in industry has revolutionized the methods of living of many people.

Unit Objectives

1. To help the pupil realize that man's knowledge of magnetism has been intimately related to his progress for a thousand years.

2. To develop a deeper appreciation for the great scientists and their contributions to mankind.

3. To develop new fields of interest.

4. To increase the pupil's scientific vocabulary.

Outline of Content

I. What are magnets and how do they work?
   A. Kinds of magnets
   B. Properties of magnets
   C. Law of magnetic poles
   D. Theory of magnetism
   E. Magnetic field

II. What is electrical energy?
   A. The electron theory
   B. Charges of electricity
      1. Positive--protons
      2. Negative--electrons
   C. Kinds of electricity
      1. Frictional or static
      2. Current or dynamic

III. How are electrical and chemical energy related?
   A. The simple cell
      1. Electrodes
      2. Electrolytes
   B. The dry cell
      1. Structure
      2. Uses

3. Types of connection
  a. Series
  b. Parallel
C. The wet cell--storage battery
  1. Structure
  2. Uses
  3. Care of
  4. Comparison with dry cell
D. Electroplating
  1. Materials needed
  2. Method used
  3. Purposes

IV. How are electrical and mechanical energy related?
  A. Electromagnetism
    1. Discoveries of Oersted
    2. Discoveries of Henry
  B. The electromagnet
    1. Essential parts
    2. Applications
      a. Electric doorbell
        (1.) Structure
        (2.) Operation
      b. Telegraph
        (1.) Development
        (2.) Use of electromagnet in sounder
        (3.) Operation of telegraph set
        (4.) Morse code
      c. Telephone
        (1.) Development
        (2.) Structure and operation of transmitter
        (3.) Structure and operation of receiver
  C. Electromagnetic induction
    1. Discovery of Faraday
    2. The electric generator or dynamo
      a. Structure
      b. Operation
      c. Function of commutator
      d. Function of transformers
      e. Importance of current electricity
    3. The electric motor
      a. Relation to the dynamo
      b. Structure of a simple motor
      c. Operation

V. How may electrical energy be controlled?
  A. Making and breaking electric circuits
    1. Devices used
    2. Function of each

B. Importance of fuses
C. The electric arc
D. Parallel circuits

VI. How is electric current measured?
A. The measurable qualtities of an electric current
1. Pressure
2. Rate of movement
3. Energy
4. Resistance
B. Units of electrical measure
1. Volt
2. Ampere
3. Watt
4. Ohm

****

Standards of Achievement

A knowledge of the principles of magnetism; the uses of magnets--electromagnets; the methods of producing electricity; the kinds of electricity. An understanding of the principle of the doorbell, telephone, telegraph, dynamo, and simple motor.

How to make and use an electromagnet; a wet cell; a simple dynamo.

How to set up parallel and series circuits--their advantages and disadvantages.

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Problem I -- What are magnets and how do they work? (pp. 320-23)

Aims: 1. To know how the earth acts as a magnet.
2. To discover the lines of force about a magnet.
3. To know how ones can make a magnet.
4. To learn what the powers of a magnet are.

Vocabulary

artificial magnet	lodestone	poles of a magnet
attract	magnet	north pole
compass	magnetic field	south pole
induction	natural magnet	repel
lines of force	polarity	

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. Do you know what magnets are and what they are made of?

2. Can a magnet be used in any other way than as a toy or novelty?

3. How does a compass tell direction?

Fables about Magnets and Magnetism (related by teacher or pupils)

1. Magnes, a Cretan shepherd, who discovered a wonderful magnetic stone.

2. The tale of the third mendicant in The Arabian Nights of a mountain which attracted passing ships.

3. A Chinese legend of the emperor's south-pointing chariot.

Demonstrations

A. Characteristics of a magnet

1. Take several pieces of lodestone. Try to pick up small objects as pins, nails, tacks, paper clips, an eraser, pieces of wood, paper, or chalk. What kind of material will lodestone attract?

2. Take two small bars of steel of the same size and weight, one magnetized, the other not magnetized. Find out which one attracts steel scraps, tacks, nails, paper clips, and so on.

3. Suspend the same two bars so that they may turn freely. The magnetized one will constantly point North and South and the other will not.

4. Collect a boxful of small objects, such as needles, pins, wire, chalk, glass, strips of copper, tin, zinc, or lead. Place a magnet on each object and try to lift it from the box. What kind of material do you find that the magnet will attract?

5. Place tacks or other small iron or steel objects on

a sheet of wood, glass, or paper. Pass a magnet along the underside of the sheet. The tacks will move along with the magnet. Magnetism passes through wood, paper, glass, or water.

B. Interesting laws of magnetism

1. Suspend a bar magnet so that it is free to turn. Allow it to come to rest, assuming a North-and-South position. The end pointing to the North is known as the north pole. This quality is called <u>polarity</u>.

2. Bring the north poles of another magnet close to the north pole of the suspended magnet. The two north poles will turn away or avoid, or repel each other. <u>Like poles repel</u>. Bring the south pole of another magnet close to the north pole of the suspended magnet. The two poles will pull each other or attract. <u>Unlike poles attract</u>.

3. Roll a bar magnet in a pile of iron filings. Lift it out. The filings cling to the ends of the magnet. Cover a U-shaped and a horseshoe magnet with filings. Lift them out. Regardless of the shape, the magnetic force of a magnet is concentrated at the ends or the poles. There is little or no attraction at the center part.

4. See how long a chain of tacks or pins can be picked up with a magnet. All tacks or pins in the chain become magnetized because of the attraction of the magnet. This force is called <u>induced magnetism</u>.

C. Magnetic field

1. Place a sheet of paper over a U-shaped magnet and shake iron filings over the paper. The filings will arrange themselves in accordance with the lines of force passing from the north pole of the magnet to the south pole.

2. Repeat the above, using a bar magnet. How does the pattern of the lines of force differ?

3. Repeat demonstration 2, using two bar magnets with the south pole of one facing the south pole of the other. Repeat but have the north pole of one magnet face the south pole of the other. Does the pattern of the lines of force differ?

Research Problems

1. Describe the type of compass that is used on ocean vessels. What does "boxing the compass" mean?

2. What type of compass is used in airplanes?

3. How could sailors steer their boats by the stars?

4. Report on the use of the compass in surveying.

5. Make a magnetic compass. See Caldwell, p. 377 for directions.

6. The following men were among the first to note and write about the powers of magnets: Thales of Miletus; Lucretius; Pliny, the historian; Peter Peregrinus; and William Gilbert. Report on their findings.

7. How would you proceed to find out whether or not a tin can is really an iron can coated with tin? Perform your experiment.

8. Make some magnetic toys. See Smith, p. 208 for directions.

CONCLUSIONS

For centuries man knew that bars of a certain metallic ore had the power to attract iron, and that if suspended they would tend to point north and south. Only with the invention of the compass, however was this knowledge made to serve man. That the compass serves us at all is due to the fact that its needle moves in response to the mysterious force of the world's greatest magnet--the earth itself.

THOUGHT QUESTIONS

1. Robert says that the magnetic pole in the northern hemisphere is a north pole; Grace says it is a south pole. Who is right and why?

2. James placed a bar magnet on a piece of cork in the swimming pool. (a)Will it point north or south? (b)Should it move toward the north end of the pool? Explain.

3. John learned that tin is not magnetic, yet he was able to pick up a "tin can" with a magnet. Account for this.

4. Is it possible to make a magnet with only one pole? Explain your answer.

5. Henry found that his screwdriver was magnetized. Suggest two ways to demagnetize it.

6. How could you use a magnet to find a needle lost in a dark spot?

7. Will a magnet pick up a tack from the bottom of a pail of water?

8. Why is a magnetic compass uncertain and difficult to use on a steel ship?

9. A science teacher found some sand became mixed with his iron filings. How might he separate the filings from the sand?

10. What do people mean by the expression, "He has a magnetic personality"?

OBJECTIVE TESTS

I

Multiple Choice

1. Which of the following substances is attracted by a magnet? (a) iron; (b) brass; (c) paper; (d) wood; (e) silver.

2. What is "lodestone"?
   (a) a stone from a gold lode;
   (b) a natural magnet;
   (c) a magnetized piece of steel;
   (d) a bar magnet;
   (e) a circular magnet.

3. What are the poles of a magnet?
   (a) the place where a magnetic needle is suspended;
   (b) the ends of the axis around which a magnet revolves;
   (c) the flattened parts of a magnetic sphere;
   (d) the points at which the magnetism seems to be concentrated;
   (e) the supports for the wires of an electromagnet.

4. What happens when the poles of a magnet are separated by cutting the magnet between the poles?
   (a) each piece then has two poles;

(b) the magnetism is destroyed;
(c) each piece continues to have one pole;
(d) each piece develops many weak poles;
(e) the strength of the magnet is decreased.

5. The north-seeking poles of two magnets will
(a) first attract each other and then repel;
(b) first repel each other and then attract;
(c) repel each other;
(d) show neither attraction nor repulsion;
(e) attract each other.

II

Select from the following list of words those which best fill the spaces in the sentences below and arrange the words in the proper numerical order. A word may be used more than once.

brass	magnetic	surrounded	field
iron	magnetized	filled	earth
steel	wood	poles	attract
silver	non-magnetic	water	repel
hard	lines	equator	force
soft	surfaces	through	plane
center	opposite	passes	compass

Magnets made of (1) .... keep their strength much longer than those made of (2) .... iron. A knife blade can be (3) .... by stroking each half from the (4) .... with the (5) .... ends of a strong magnet. Every magnet is (6) .... by a magnetic (7) .... which is filled with (8) .... of magnetic (9) .... Like magnetic (10) .... (11) .... but unlike (12) .... poles (13) .... each other. The needle of the magnetic compass takes the direction of the (14) .... lines of (15) .... of the (16) .... Magnetism (17) .... through (18) .... which are (19) ...., such as glass, copper, and wood. A magnet will attract only (20) .... substances.

Problem II -- What is electrical energy? (pp. 323-325)

Aims: 1. To find out how a substance may be charged with electricity.
2. To know the effects of static electricity.

Vocabulary

atom	lightning rod
attraction	neutral body
dynamic electricity	nucleus
electron	proton
electroscope	repulsion
lightning	static electricity

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. Can a person become charged with electricity?

2. Why does the hair sometimes snap when being combed with a rubber comb?

3. Why are lightning rods placed on farm buildings?

Demonstrations

1. Producing static electricity
Clement-Collister-Thurston, p. 204 or Westinghouse booklet "A Course in the Fundamentals of Electricity" p. 10

2. Properties of electrified bodies
Hunter, My Own Science Problems, p. 175

3. Storing static electricity
Westinghouse, p. 13

Things to Do

1. What is the story of Benjamin Franklin's securing electric charges from the clouds by means of a kite? Did Franklin run any risk in performing this experiment? Explain.

2. Make a list of precautions to be taken in order to avoid being struck by lightning.

3. Make your own electroscope. See Hunter, <u>My Own Science Problems</u>, p. 183 <u>or</u> Smith, p. 212 for directions.

4. Make a toy which depends on static electricity. See Smith, p. 214.

CONCLUSIONS

As long ago as 600 B.C. the Greeks knew that amber, when rubbed, temporarily acquired the power of attracting light objects. The Greek name for amber is "elektron." From it we derive our word <u>electricity</u>.

There are two kinds of electricity. If you rub different substances together one kind of electricity appears on the rubbed object, the other on the rubbing body. Benjamin Franklin was the scientist who first called the two kinds of charges positive and negative.

THOUGHT QUESTIONS

1. Mary walks across a heavy rug. How can a pith ball be used to determine if she has developed a charge by friction and what kind of charge is it?

2. How does the electron theory account for the charge on (a) glass when rubbed with silk, (b) sealing wax when rubbed with flannel?

3. When caught in a thunderstorm, James sought shelter under a tree in a field while John ran into a nearby forest. Who was safer and why?

4. Gasoline trucks are frequently equipped with a short chain which drags on the ground in back of the truck. Account for this.

5. Helen observed that on certain days sheets of paper stick to the rotary mimeograph and do not discharge properly from the machine. Explain.

6. Is it true or false that a modern steel building does not need lightning rods?

7. Why is it advisable to have lightning rods grounded in moist earth rather than in dry earth?

8. Why is a spark sometimes produced when one rubs a cat's fur backwards?

9. Sometimes motion-picture films have been ruined when run through the projector due to minute flashes of static electricity. What would cause these flashes?

10. How may one reduce the danger of being struck by lightning?

OBJECTIVE TESTS

I

True-False

1. Like charges attract each other, and unlike charges repel each other.

2. When a body loses some of its electrons, the body is negatively charged.

3. When a body attracts small bits of paper, we know that the body is electrified.

4. Negative particles of electricity are called electrons.

5. An atom consists of a nucleus of electrons surrounded by protons.

II

Multiple Choice

1. A glass rod rubbed with silk will (a) attract; (b) repel; (c) neither attract nor repel the silk with which it is charged.

2. A charged atom is called (a) a neutron; (b) an ion; (c) an electron.

3. The removal of electrons from an object causes that object to become (a) negatively charged; (b) positively charged; (c) neutral.

4. An atom has a nucleus of (a) ions; (b) protons; (c) electrons.

5. Electricity produced by friction is called (a) static electricity; (b) current electricity; (c) dynamic electricity.

Problem III -- How are electrical and chemical energy related? (pp. 325-332)

Aims: 1. To learn how a storage cell is made and works.
2. To know the use and care of storage batteries and dry cells.
3. To discover how electricity is used to plate a
3. piece of metal.

Vocabulary

anode	electrolyte	positive
battery	electroplating	resistance
cathode	hydrometer	series
circuit	ions	specific gravity
current	negative	storage battery
electrode	parallel	terminals
		voltage

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. What is a battery?
2. How is an automobile battery charged?
3. Where would you use dry cells to produce electricity?
4. What is electroplating? What are some of its uses?

Demonstrations

1. Voltaic pile
   Westinghouse booklet, p. 20
2. Wet cell
   text, p. 326
3. Dry cell
   Davis and Sharpe, p. 230
4. Storage cell
   text, p. 329
5. Connection of cells
   Davis and Sharpe, p. 231
6. Electrolysis of water (optional)
   Davis and Sharpe, p. 232

7. Electroplating
   text, p. 331

8. Electrotyping (optional)
   Caldwell and Curtis, p. 393

<u>Research</u> <u>Problems</u> <u>and</u> <u>Projects</u>

1. Secure an old automobile battery, take it apart and examine its construction. Make a labeled sketch showing the construction. Do the same with a discarded dry cell.

2. How does the Edison storage cell differ from the lead storage cell? In what ways is each superior to the other?

3. What are the various uses of electrical currents in airplanes, dirigibles, blimps, and other aircraft?

4. Make a diagram to show how six dry cells would be connected to be two in series by three in parallel.

5. If a dry cell is cut in half cross-wise, can the parts be used at all to supply current?

6. Find out what you can about the torpedo fish and the electric eel.

7. Report on what Benjamin Franklin did for electricity.

8. Operate a flashlight in a dark room to discover if you can observe any falling off in its brightness during a fairly brief period of continuous operation.

9. Report on the work of Galvani and Volta.

10. Make an electric cell from a lemon. See Smith, p. 215 for directions.

11. Make an electric cell in a soup plate. See Smith, p. 216 for directions.

CONCLUSIONS

The electric cell is the result of the discovery by two Italians, Volta and Galvani, that electric charges can be produced by chemical action. Every electric cell consists of two plates of different materials in a liquid which will carry a current. There are many different types of cells but the only ones in common use are the dry cell and the storage cell.

THOUGHT QUESTIONS

1. James sawed a "dead" dry cell lengthwise with a hacksaw and found it to be dry. It neither rang a bell nor gave a meter reading. When immersed in water, it did both. Account for this.

2. (a)When Henry buys dry cells he always asks if they are dated. Why? (b)Is it good practice for a dealer to stock a year's supply of such cells? Explain.

3. Charles wishes to plate an iron ring with copper. List the materials needed and explain the process.

4. State two advantages storage cells have over dry cells.

5. Why are "dry cells" so called?

6. Why do storage batteries lose their "charge" if allowed to stand unused?

7. How do you test the state of a storage battery with regard to its charge?

8. Should acid or water be added to a storage battery and where should the level of the liquid be kept?

9.. What advantages does a dry cell have over a wet cell of the same type?

10.. How are cells connected to increase pressure?

OBJECTIVE TESTS

I

True-False

1. An electric cell consists of two electrodes and an electrolyte.

2. Electric cells transform kinetic energy into electrical energy.

3. When cells are connected in series, the positive pole of the first cell is connected with the positive pole of the next cell.

4. A storage cell does not store electricity, it stores chemical energy.

5. Dry cells have higher voltage than storage cells.

II

Multiple Choice

1. In electroplating, the article to be plated is called (a) the anode; (b) the cathode; (c) the electrolyte.

2. The chemical used in the lead storage battery is (a) hydrochloric acid; (b) sal ammoniac; (c) sulphuric acid.

3. When a number of dry cells are joined positive pole to negative pole, they are joined in (a) parallel; (b) series; (c) resistance.

4. The instrument used to measure the specific gravity of liquids is (a) the thermometer; (b) the hygrometer; (c) the hydrometer.

5. One of the electrodes of a dry cell is carbon, the other is (a) copper; (b) lead; (c) zinc.

##

Problem IV -- How are electrical and mechanical energy related? (pp. 333-343, 384-386, 461-472)

Aims:
1. To discover what is meant by electromagnetic force.
2. To learn something about the early methods of communication.
3. To discover how the telegraph works.
4. To discover how a telephone carries the human voice.
5. To know how electricity is used in communication.
6. To discover how an electric motor works.
7. To understand the uses of a good electric motor.

Vocabulary

alternating current	dynamo	motor
armature	electromagnetic induction	receiver
brushes		sounder
commutator	carbon granules	telegraph
core	electromagnetism	telephone
diaphragm	impulses	transformer
direct current	generator	transmitter

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. What is a generator?

2. If the motor had not been invented what machines would the world now lack?

3. Why did early peoples know little of each other?

4. How has the invention of the telephone aided the deaf?

5. How many methods of communication can you name that are used by people today?

Demonstrations

1. How can one make and use and electromagnet?
   text, p. 335
   Caldwell and Curtis, p. 386
   Davis and Sharpe, p. 240

2. What is the structure of the doorbell? How does it make use of electromagnets?
   text, p. 336
   Davis and Sharpe, p. 256

3. How are induced currents produced?
   Caldwell and Curtis, p. 387
   Davis and Sharpe, p. 241

4. What is the principle of the electric motor?
   Davis and Sharpe, p. 258

5. How does the electric telegraph work?
   Hunter, Science in Our World of Progress, p. 307
   Davis and Sharpe, p. 259

6. What is the principle of the telephone?
   text, p. 470

7. What is the action of the telephone transmitter?
   Hunter, Science in Our World of Progress, p. 311

8. What is the action of a telephone receiver?
   Hunter, ibid., p. 312
   Davis and Sharpe, p. 263

9. What is the use of a tranformer?
Hunter, Science in Our World of Progress, p. 207

Research Problems and Projects

1. How are electromagnets used on farms? In hospitals? In offices? In factories?

2. List all the means of communication used in your home. Besides each item, name the structure used to carry on this information.

3. What are Elisha Gray's claims as the inventor of the telephone?

4. List all the men who have had some share in perfecting the modern telephone and tell of their contributions.

5. We are likely to have the idea that the telegraph was invented by Morse. Actually it was the invention of two Englishmen, Wheatstone and Cooke. Report on their instrument and telegraph system.

6. Find out how smoke, drums, fires, and mirrors have been used in the past for purposes of communication.

7. List the advantages and disadvantages of the telephone as compared with the telegraph.

8. Report on the life and work of the following men:
Hans Oersted
Joseph Henry
Michael Faraday
Alexander Graham Bell
Samuel F.B. Morse

9. Diagram a system of electric connections in which a bell and a buzzer are both connected to the same battery of two dry cells and are so arranged that the bell will be rung by a push button at the front door and the buzzer will be rung by a push button at the back door. Set up the apparatus according to your diagram and see whether your solution of the problem is correct.

10. Make a diagram for the following problem: Locate a bell in each of two rooms and a cell in one room only. Arrange the wiring so that the push button in either room will ring only the bell in the other room. Set up the apparatus to test the correctness of your diagram.

11. Can you solve the preceding problem by using only three wires which go from one room into the other?

12. Make a buzzer. See Smith, p. 221 for directions.

13. Make a tin-can telephone. See Hunter, p. 339 for directions.

14. Make a telegraph sounder. See Hunter, p. 340 for directions.

15. Make a communication scrapbook. Collect pictures and clippings that have to do with early and present-day methods of communication.

16. Topics for debates.

Resolved: That the telephone is a more important invention than the telegraph.

Resolved: That the ability to receive eye signals is of more importance to man than the ability to receive ear signals.

CONCLUSIONS

Scientists found that when a wire is revolved between the poles of a magnet, an electric current is generated. It was soon found that this current was a movement of electrons. Thus it was found that an electric current may be generated by a <u>dynamo</u> and it is used, by means of <u>motors</u>, to run machinery.

The discoveries and inventions of Oersted, Henry, and Faraday led up to the invention of the telegraph by Morse. This sending of code impulses on wires by electric current at once changed our whole world environment. In 1876 Alexander Graham Bell, using the findings of previous experimenters was able with the aid of electric currents, electromagnets, and a sensitive diaphragm to send electrical impulses produced by the human voice over a wire for the first time.

THOUGHT QUESTIONS

1. Why not make the core of electromagnets of steel?

2. When an electromagnet is lifting a load of iron, what is done to make the electromagnet drop its load?

3. Mention three electric devices resulting from Oersted's discovery and three that have resulted from Faraday's.

4. What changes should you have to make in an electric bell to make it a single-stroke bell instead of a vibrating-armature bell?

5. In what way is the push button in an electric bell circuit like an electric switch?

6. What causes a telegraph instrument to "click" when the key is pressed?

7. Why does the armature of an electric bell vibrate when current flows through its coils?

8. Joseph Henry knew nothing about the telegraph until Morse developed it. Yet the telegraph might well have been impossible without him and Faraday. How do you explain this statement?

9. Is the voice of a person using a telephone actually heard by the person at the other end of the line?

10. What do people mean when they say of some one, "He is a human dynamo"?

OBJECTIVE TESTS

I

Multiple Choice

1. The discoverer of induced currents was (a) Edison; (b) Oersted; (c) Faraday.

2. The purpose of the commutator in the electric motor is to (a) cause a magnetic field; (b) reduce the resistance of the armature; (c) reverse the current in the armature.

3. Increasing the current in an electromagnet makes it (a) have more magnetism; (b) have less magnetism; (c) have more magnetism.

4. A device which permits an electric generator to deliver direct current to an external circuit is called (a) an armature; (b) a field pole; (c) a commutator.

5. Voltage is stepped up or stepped down by means of (a) fuses; (b) commutators; (c) transformers.

Completion

1. The moving part of a motor is called the ....

2. The device used to change alternating current to direct current is the ....

3. The electromagnet was invented in 1825 by an Englishman named ....

4. The soft iron bar in an electromagnet is called the .....

5. In the electric bell the circuit is made and broken at the ....

##

Problem V -- How may electrical energy be controlled? (pp. 343-353)

Aims: 1. To learn how to set up an electric current.
2. To discover how fuses work.
3. To understand the uses of electricity in the home.

Vocabulary

conductor	electric arc	plugs
conduit	fuses	short circuit
device	insulator	sockets
		switches

SUGGESTED TEACHER PROCEDURE

Survey Questions

1. What effect does the turning or pushing of a switch button have on the electric lights in your home? Can you explain this?

2. Why are all electric wires covered with insulation?

3. What is a fuse? How does it protect our homes from fires?

Demonstrations

1. How can an electric circuit be set up correctly, adjust-

ed, and tested for proper control?
text, p. 344

2. How are electric circuits made and broken?
text, p. 346

3. How do fuses protect the house?
Caldwell and Curtis, p. 403

4. How do fuses work, and why are they important?
text, p. 347

5. What is the principle of electric heating?
Caldwell and Curtis, p. 402
Davis and Sharpe, p. 243

6. How is an electric circuit grounded, and why is it important that you know the dangers of grounding?
text, p. 349

Things to Do

1. Prepare an illustrated report of the devices used to control electric currents.

2. Take an old fuse apart. Report on its structure.

3. Examine the wiring in your home. Locate the main house switch, the fuses, and the meter. Make a diagram showing how the wires enter and leave these devices.

4. Make a careful study and report on safety factors in the use and control of electricity.

5. Carefully take apart a cord switch. Examine its parts and describe its operation. Put it together again.

CONCLUSIONS

Current electricity is controlled by switches, by the size of the wire used to carry the current, and by fuses. Too great strength (Amperage) of current on a wire may blow the fuses, but this prevents fires. Dangers in electric circuits arise from short circuits, grounding, and electric arcs. These dangers may be prevented by the proper use and care of insulation and conduits, and by skill in making connections.

THOUGHT QUESTIONS

1.(a) Why are fuses necessary in an electriccircuit? (b) Robert used a coin to replace a fuse. Why is this dangerous?

2. What is a "short circuit"? Why is a short circuit apt to cause a fire?

3. Explain why the bare wires leading to an electrical device should never be allowed to touch each other while the current is flowing through the wires.

4. Should a thirty-ampere fuse be put on a fifteen-ampere wire?

5. Why do men handling electric wires often use rubber gloves?

6. Why are the insulated wires of a house lighting system usually carried in metal tubing?

7. What is the reason for wiring all buildings in parallel?

8. What precautions must be taken before removing and replacing fuses?

9. After connecting a new and untried electric table lamp, all of the lights went out. They could not be turned on again at the switch. What was the most probable reason for the failure of the lights?

10. Why is it dangerous to turn on an electric light or switch while standing on a cement, iron, or wet earthen floor, unless you are wearing rubbers?

OBJECTIVE TEST

Multiple Choice and True-False

1. (a) Iron; (b) copper; (c) lead is the best conductor of electricity.

2. A fuse should have (a) more; (b) less; (c) the same carrying capacity as the wiring in a circuit.

3. Electric house lamps are always connected in series.

4. A fuse wire completes the circuit when the current becomes unusually great.

5. A fuse wire has higher resistance and is a better conductor than the copper wire which composes the rest of the circuit.

###

Problem VI -- How is electric current measured? (pp. 353-356)

<u>Aims</u>: 1. To discover the various terms used in measuring electric current.
2. To understand the relationship between volts, amperes, and ohms.
3. To learn how to read an electric meter and to compute an electric bill.

<u>Vocabulary</u>

ammeter	pressure
ampere	resistance
electromotive force	voltage
kilowatt hour	voltmeter
ohm	watt

SUGGESTED TEACHER PROCEDURE

<u>Survey Questions</u>

1. What device measures the amount of electric current used in a building?

2. Describe the face of an electric meter.

3. Does the size and/or the length of a wire affect the pressure of the current it carries?

<u>Demonstrations</u>

1. How is electricity measured? Wire resistance to electricity? Electrical pressure? Electrical current?
Hunter, <u>Science in Our World of Progress</u>, pp. 199-202

2. What is the relation between volts, amperes, and ohms?

Connect four dry cells in series. Place in the circuit a six-volt lamp and its socket, and also a resistance coil, leaving one end of the circuit free. (The lamp = current in

amperes; the dry cells = pressure in volts; and the resistance coil = resistance in ohms.) Now touch the free end of the wire to the negative terminal of dry cell No. 1. Watch the lamp. Try the same method with cells 2, 3, and 4. Repeat your test, at the same time touching the ends of a piece of insulated wire to the resistance coil terminals. Watch the lamp. How did you affect the voltage? the amerage? the resistance? What relations between voltage, amperage, and resistance have you shown here?

3. How does one read an electric meter?
Hunter, <u>Science in Our World of Progress</u>, p. 202

<u>Class Exercises</u>

A. After studying the way the cost of service is computed in section 263, p. 355 of the text, work out the following simple problems:

1. How many watts are used by a toaster which uses 4 amperes of current on a 110-volt line? Find the cost at 10 cents per kilowatt.

2. If an electric lamp uses 1000 watts of power in 20 hours, what is the wattage of the lamp?

3. An electric iron used 1100 watts on a 110-volt line. What is the amperage stamped on the iron?

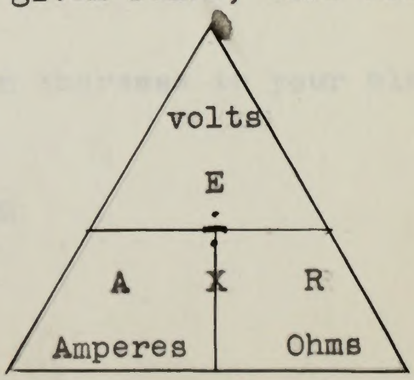
4. A toaster with a 10-watt amperage used 1100 watts in one-half hour. What was the voltage of the line?

B. Study Ohm's Law, p. 355 or use Westinghouse booklet, <u>Amber and Amperes</u>, and with the diagram given below, work out the following simple problems:

1. A bell uses .1 ampere of current whose voltage is 3. What is the bell's resistance?

2. A vacuum cleaner uses 11.5 amperes of current whose voltage is 115. What is the resistance of the cleaner?

3. An electric lamp is placed in a 110-volt circuit. Its resistance is 220 ohms. How much current



E ÷ A = R
E ÷ R = A
A x R = E

will pass through the lamp?

(For additional problems, see Lynde, pp. 334-336)

Things to Do

1. Learn how an electric bill is computed in your community. Use an old bill for the schedule of rates.

2. Take the reading of your electric meter weekly. Calculate the weekly cost of the electricity used.

3. Make a simple ammeter. See Hunter, Science in Our World of Progress, p. 216 for directions.

CONCLUSIONS

Electric current or power is sold by the kilowatt hour. The kinds of electrical units are: the ampere, the unit of measure of rate of current flow; the watt, the unit of power; the volt, the unit of pressure; and the ohm, the unit of resistance.

THOUGHT QUESTIONS

1. In what ways are electric pressure and water pressure alike? Unlike?

2. Why are our electric bills rendered in kilowatt-hours?

3. How are cells connected to overcome high resistance?

4. How are cells connected to increase pressure?

5. Which has more resistance, a large wire or a small wire? A long wire or a short wire?

6. What are some of he causes of an increase in your electric bill?

OBJECTIVE TESTS

I

Multiple Choice

1. A watt is a unit of (a) energy; (b) current; (c) power.

2. The combined voltage of two dry cells connected in paral-

lel is (a) greater than; (b) less than; (c) the same as the combined voltage of two dry cells connected in series.

3. The electrical pressure in a circuit is called (a) resistance; (b) power; (c) voltage.

4. The term power means (a) energy; (b) voltage; (c) rate at which work is done.

5. Electric power is found by multiplying the amperes by the (a) ohms; (b) watts; (c) volts.

II

Select from the following list of words those which best fill the blank spaces in the sentences below and arrange them in the proper numbrical order. The same word may be used more than once.

kilometer	parallel	voltage	amperes
second	kilowatt-hour meter	series	watts
hour	volt	greater	volts
pressure	ampere	less	power
current	watt	kilowatt	voltmeter

The resistance to an electric current is (1) .... in a long than in a short wire and (2) .... in a wire of large diameter than in one of small diameter. The unit in which electrical pressure is measured is the (3) .... ; the unit of current strength is the (4) .... If we join two cells in (5) ...., the (6) .... will equal the sum of the two. The voltage of two cells is the same as that of a single cell if they are joined in (7) .... The electricity we buy is measured with a (8) .... , and we pay for it at so much per (9) .... (10) ....

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[2] These pamphlets are free and are obtainable in quantity. See p. 108 for the address.

CONCLUSION

The chief function of this service paper is to provide a guiding outline (course of study) for the teachers of general science in the junior high schools of X-city. Although objectives, demonstrations, research problems, etc. have been listed, no formal lesson plans have been included. No two teachers approach a problem in the same manner and all problems should not have the same method of development if they are to be solved successfully. An ingenious teacher does not follow a stereotyped lesson plan.

However, the development of all lessons should lead to the comprehension of the principles involved in the problem of the day. The teacher will realize that a comprehension of the principles is more important than a mere knowledge of them. Appendix A is a compilation of all the principles listed in the various sections of this service paper. The suggestion is made by the author that the teacher take these principles and carefully allocate them to the topics he will teach. Many of the principles must be restated in more simple language, especially those for the two lower grade levels. The author used the ordinary textbook language as time did not permit restating the principles.

Many of the demonstrations have two or more references listed under them. The reason for this is that their development differs in each source and the teacher can decide which will

better suit his purposes. These demonstrations can, for the most part, be performed by the pupils themselves, however it is necessary that the teacher explain and show what principles are involved. It is not wise to allow the same pupil or pupils to always have an active part in the demonstrations--allow every pupil in the group to be the demonstrator or assistant to the demonstrator at least twice during the school year.

It is well to have the pupils, both the participant(s) and audience write a report of the demonstration following an outline which has been recommended by the teacher. This reporting may be considered as either notebook work or a homework assignment or both.

In order to have the pupils better appreciate the work of scientists the teacher should have them do a little directed research into simple problems. Needless to say, very few pupils know to use the reference books of a library when they enter the senior high school. The science classes offer an excellent opportunity for the junior high school pupil to become acquainted with his public library. However, care must be taken in the selection of topics for reference work so that the findings will be understood by the pupil. It is senseless to have a pupil give or write a report about something of which he has little understanding.

Appendix B gives suggestions for administering the objective tests. The final bibliography does not include any of the books, pamphlets, periodicals, etc. that have already been included in a

previous listing.

APPENDIX A

COMPILATION OF SCIENTIFIC PRINCIPLES

Adaptation to Environment

1. All living things must adapt themselves to the conditions under which they live or become extinct.

2. Species have survived because by adaptations and adjustments they have tended to become better fitted to the conditions under which they live.

3. Man has become an important determining factor in the environment of all life. His continued existence and advancement are dependent upon his wise modification and control of his environment.

4. Man's way of living is governed by the conditions that surround him on the earth.

5. The environment causes changes in living things and living things cause changes in the environment.

Air

1. The earth and its life are greatly affected by the ocean of air which completely surrounds it.

2. Air has weight on account of the pull of the earth's gravity.

3. Air and other gases tend to expand until they occupy all portions of the containing vessel.

4. The pressure of the atmosphere decreases as the altitude increases, and increases as the altitude decreases.

5. The atmosphere exerts pressure on every surface it touches.

6. The suction of an air pump produces a partial vacuum in a cylinder.

7. Warm air is lighter than cold air.

8. All living things use oxygen to change food into heat and into other forms of energy.

9. Weather varies with variations in air pressure.

10. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it.

11. Different temperatures cause differences in atmospheric pressure and these differences in atmospheric pressure cause winds.

12. Air moves from points of greater pressure to points of less pressure, causing air currents or winds.

Bacteria

1. Bacteria reproduce rapidly where there is warmth, moisture, and food.

2. Decaying food promotes the growth of bacteria.

3. Decay of food is caused by bacteria and molds.

4. Excessive heat kills organisms.

5. If some kinds of germs enter a cut or wound, infection may follow.

6. The body has natural defenses against germs.

Conservation

1. All living things are helped by the activities of some other living things and are harmed by the activities of still other living things.

2. Living things are constantly striving with each other for the available supply of food.

Electricity and Magnetism

1. Like charges repel each other, and unlike charges attract each other.

2. Magnetic poles of the same kind repel each other, and magnetic poles of opposite kind attract each other.

3. An electrical current may be produced in three ways: by rubbing, or friction; by chemical action; and by the use of magnets.

4. The applications of electricity and magnetism in the home and industry have revolutionized the methods of living of many people.

5. Electrical energy can be transformed into mechanical energy.

6. The larger the wire, the less the resistance will be to a current.

7. Electrical current is used to produce heat or light and to produce motion in an electric motor.

8. The strength of an electrical current can be regulated by changing the voltage and the resistance of the circuit.

9. When a coil of wire is made to cut through lines of magnetic force, a current of electricity is produced in the wire.

10. Whenever electrical currents flow through conductors, some of the electrical energy is changed to heat energy, and sometimes some of it is changed to light energy.

11. All matter is probably electrical in structure.

12. The earth acts as a huge magnet with magnetic poles.

13. Lightning is static electricity.

14. There are only a few metals that can be magnetized or that can be attracted by a magnet.

15. Neutral bodies become charged electrically upon gaining electrons or upon losing electrons.

16. Electrical energy can be measured.

17. The characteristics of an electric current may be changed by a device called a transformer.

18. Electricity is believed to consist of negative particles called electrons and positive particles called protons.

19. Electrical energy is produced only at the expense of some other kind of energy.

20. Every wire carrying an electrical current is surrounded by lines of magnetic force.

Energy

1. Every cause has its effect; every effect its cause.
2. One kind of energy can readily be changed into other kinds.
3. Energy and matter can neither be created nor destroyed but may be transformed from one form to another.
4. When energy is doing something, it is active or kinetic.
5. Chemical and physical changes are manifestations of energy.
6. A chemical change is one in which a new substance is formed.
7. A physical change is one which changes the shape or appearance of something but does not change the materials of which it is made.
8. Oxidation is the reaction between the oxygen of the air and other substances.
9. Some chemical changes are helpful; some are harmful.
10. Heat is a form of energy released by the oxidation of fuels.

Food

1. All living things require energy in the form of food.
2. All living things use oxygen to change food into heat and into other forms of energy.
3. We need a variety of food.
4. Foods come from plants, animals, and inorganic matter.
5. Foods are used for growth, energy, and regulation of the bodily activities.
6. Vitamins are essential to life.
7. Food must be digested before it can be used by the body.

Fire

1. Combustion will not take place without oxygen.
2. Things gain in weight when they burn.
3. When anything burns, oxygen is used and carbon dioxide is given off.

Health

1. Life is dependent upon certain materials and conditions.
2. All living things require energy in the form of food.
3. Vitamins are essential to life.
4. Food must be digested before it can be used by the body.
5. Foods are used for growth, energy, and regulation of the bodily activities.
6. Bones act as levers while muscles exert power and give us movement of the body machine.
7. The nervous system controls the human machine.
8. Bones are adapted for special uses.
9. Digestion consists of transforming foods into a liquid form so that they may be absorbed by the blood stream and then the cells.
10. Efficient living is dependent upon knowledge of the principles of health and sanitation.
11. The body has natural defenses against germs.
12. If some kinds of germs enter a cut or wound, infection may follow.
13. Public and private health is not possible without co-operation on the part of individuals.
14. Green plants, using the energy of sunshine, make food out of water and carbon dioxide.
15. Certain amount of light, heat, moisture, oxygen, and food are necessary to the life of most living things.

16. Communicable diseases are caused by germs.

17. We are absolutely dependent upon green plants for food.

Heat

1. Heat hastens evaporation.

2. Heat is a form of energy released by the oxidation of fuels.

3. Heat may be transferred by conduction, convection, and radiation.

4. Radiators expose large surfaces to the air and permit the transfer of heat to the air.

5. Some materials are good conductors, others are poor conductors.

6. Non-conductors or insulators are used to prevent the loss of heat.

7. Heat is required to change a liquid to a gas.

8. In general, bodies expand when heated and contract when cooled.

9. Whenever two bodies having different temperatures are in contact, the warmer body gives some of its heat energy to the colder one.

10. Electrical energy can be transformed into heat energy.

11. All substances have their own specific boiling point, freezing point, and kindling temperature.

12. Dark-colored, rough, or unpolished surfaces absorb radiant heat energy more rapidly than light-colored, smooth, or polished surfaces.

13. The sun is the source of almost all the energy available on the earth.

The Heavens

1. The sun is the source of almost all the energy available on the earth.

2. All bodies in the solar system are controlled by the gravitational attraction of the sun.

3. Two balancing forces, motion and gravitation, tend to keep the astronomical bodies in place.

4. The movements of the solar system and of the stars continue in a regular uniform motion.

5. The planets revolve around the sun in periods which vary with their distances from the sun.

6. The earth's position and relation to the sun and moon are of great importance to the life of the earth.

7. A great passing star may have pulled some of the gaseous material from our sun, thus forming the beginning of our earth, the planets, and moon.

8. The rising and setting of the sun, moon, and stars is due to the rotation of the earth.

9. Eclipses are caused by the earth's shading the moon or by the moon's shading the earth.

10. Tides are caused by the attraction of the moon.

<u>Light</u>

1. Light is indispensable to life.

2. Light travels in straight lines at a velocity of 186,000 miles a second.

3. When light strikes an opaque object, a shadow is formed behind the object.

4. When light strikes a surface, part of it is reflected from the surface.

5. Light rays are bent as they pass from one transparent substance into another.

6. Some objects give off light of their own, while some are seen only by reflected light.

7. We see objects when light from those objects enters our eyes.

8. Dark-colored, rough, or unpolished surfaces absorb light more rapidly than light-colored, smooth, or polished surfaces.

9. When light rays from an object pass through a small hole against a screen of some kind, an inverted image of the object is formed.

10. White light is a mixture of colors.

Living Things

1. All living things are composed of very small units called cells.

2. Life is dependent upon certain materials and conditions.

3. All living things use oxygen to change food into heat and into other forms of energy.

4. All living things require energy in the form of food.

5. All living things are helped by the activities of some other living things and are harmed by the activities of still other living things.

6. Living things are constantly striving with each other for the available supply of food.

7. All life comes from pre-existing life and reproduces its own kind.

8. There is a great variety and range in the size, structure, and habits of organisms.

Matter

1. All matter is either a solid, a liquid, or a gas.

2. All matter is made up of tiny particles called molecules and these molecules are in constant motion.

3. When a solid changes to a liquid, and a liquid to a gas, heat is absorbed, and conversely.

4. Every body has weight and occupies space.

5. Gravity gives objects weight.

6. Any substance that will turn black and char when burned is organic matter.

7. A body at rest remains at rest and a body in motion remains in motion unless acted upon by some external force.

8. No two objects can occupy the same space at the same time.

9. Matter is anything that occupies space.

10. Matter can be changed in form but cannot be created or destroyed.

11. There are fewer than one hundred elements.

12. Every substance is an element, a chemical compound, or a mechanical mixture.

Rocks and Soils

1. Rock fragments and organic remains form soil in which plants grow.

2. The surface of the earth is constantly changing.

3. Rocks are made in three ways: under water, by pressure, and by heat.

Sound

1. Sounds are produced by vibrations and are carried by solids, liquids, and gases that vibrate.

2. Sounds travel in waves.

3. Sounds may be musical or may be mere noise.

4. The more rapidly a body vibrates, the higher is its pitch.

Water

1. Water exists three states: solid, liquid, and gaseous.

2. Water exerts pressure because of its weight.

3. The pressure under water becomes greater as the distance below the surface becomes greater.

4. Running water always seeks a lower level.

5. Water tends to flow from regions of greater pressure to regions of lower pressure.

6. Warm water is forced upward by the falling or settling of colder water.

7. When water evaporates, an invisible gas is formed.

8. Heat hastens evaporation.

9. Heat taken away from water vapor causes it to condense.

10. Evaporation follows precipitation, and precipitation follows evaporation, in endless succession.

11. Water in nature is never absolutely pure, but contains some dissolved substances and some other substances which will not dissolve in it.

12. Dissolved material can be removed from a liquid by distillation.

13. Undissolved material suspends in water and may be removed by sedimentation or be filtering.

14. Water is a universal solvent.

Weather

1. Weather varies with variations in air pressure.

2. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it.

3. Differences in temperature cause differences in atmospheric pressure, and these differences in atmospheric pressure cause winds.

4. Air moves from points of greater pressure to points of less pressure, causing air currents or winds.

5. Evaporation follows precipitation, and precipitation follows evaporation, in endless succession.

Work

1. A machine is a device to enable man to do his work more advantageously.

2. Machines, no matter how complicated, may be analyzed into a few simple types.

3. There is always friction whenever work is done and this friction produces heat.

APPENDIX B

SUGGESTIONS FOR ADMINISTERING OBJECTIVE TESTS

The use of objective tests is more likely to encourage more careful study and planned review because the reactions to objective statements are specific, are either known or not known by the student, and if not known no amount of writing "around" the subject will help.

Clear, definite directions should precede the beginning of student work on the test. If the test is to be dictated the teacher should advise students[1] that: "(1) the statements will be read twice, (2) students should get the idea of what the statement is about at the first reading, (3) the reaction should be made following the second reading, (4) if the student wishes a third reading, he should so inform the teacher upon the completion of the second reading, (5) statements will not be reread after the test has proceeded to another item because of the confusion likely to result."

Objective tests are numerous in type: completion, true-false, multiple-choice, matching, identification, correction of form, etc.

In order to eliminate the possibility of guess-work in the true-false test, it is advisable (if time permits) to have the student rephrase a false statement to make it a true statement or to simply tell why the statement is false.

[1]William L. Wrinkle and Winfield D. Armentrout, Directed Observation and Teaching in Secondary Schools, New York: The Macmillan Company, 1937, p. 276.

When giving a completion test in the form of a paragraph, the teacher should advise the pupils to read the sentences in their entirety after filling in the blanks to look for sentence structure as well as comprehension. Frequently if the work is done phrase by phrase, the wording seems to be correct until the phrases are put together to form sentences.

If tests are to have the greatest instructive values, they should be discussed in class. The discussion should follow the test period as closely as possible.

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